The American Journal of Surgery

EDITED BY THURSTON SCOTT WELTON, M.D.

Obstetrics

Anesthesia . Orthopedic Surgery

Gynecology . Proctology

Special Article

MALFORMATIONS OF THE UTERUS

By Julius Jarcho, M.D.

FIFTY-FIFTH YEAR OF CONTINUOUS PUBLICATION

January 1946

VOLUME LXXI NUMBER I

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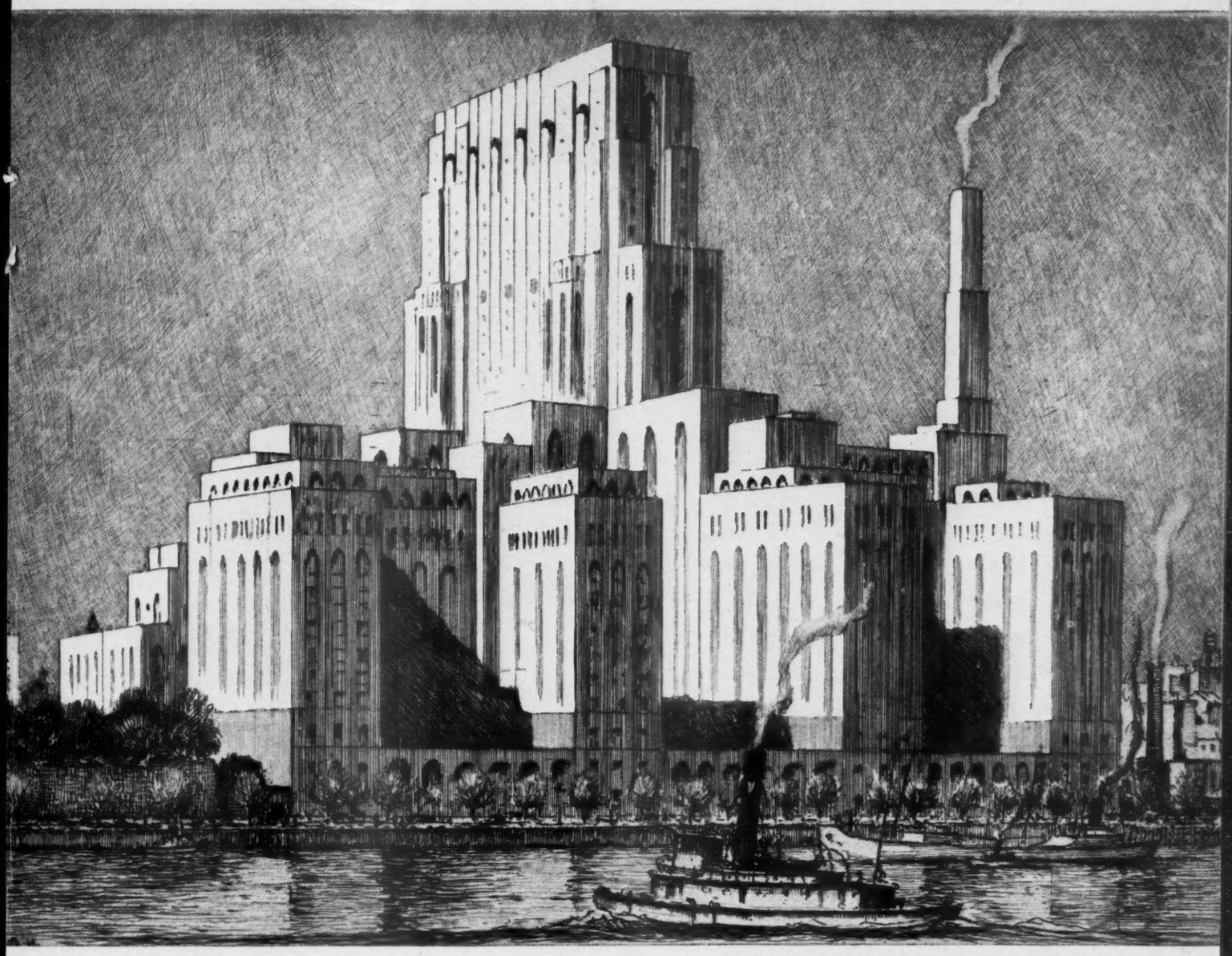


FROM AN ORIGINAL ETCHING BY ERNEST D. ROTH

THE CORNELL UNIVERSITY MEDICAL COLLEGE—This famous medical school was established in 1898 in New York City, with funds provided by Colonel Oliver H. Payne. From the beginning, its aim has been twofold . . . to develop physicians and surgeons of the highest order and to extend medical knowledge through research. Today, Cornell Medical College is housed in a group of modern buildings comprising a great medical center, and is operated in association with the New York Hospital. Cornell Medical College is distinguished for its general surgical training, with particular emphasis on gynecological, obstetrical and urological aspects of surgery.

Advances in surgical technique depend not only on increasingly efficient application of modern knowledge, but also on the constant acquisition of new information. Described and illustrated on the following pages is the last in the series of "Incisions That Minimize Wound Disruption." The complete series in booklet form will be made available shortly by D&G, and may be obtained on request.

Incisions that Minimize

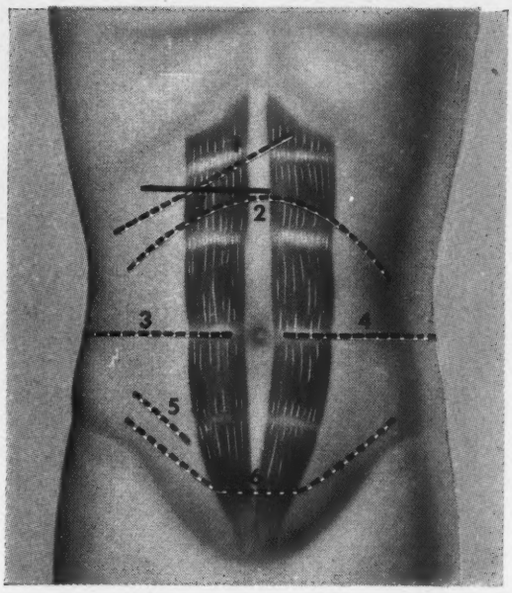
The employment of operative incisions which offer maximal assurance against sutures pulling through the tissues eliminates one of the principal causes of wound disruption and lessens the possibility of post-operative herniation.

Sutures hold most securely if the connective tissues within the wound are approximated in such a manner that the sutures must pull against the fibres within these layers. This necessitates cutting the connective tissues parallel to the direction of their fibres which, in the anterior abdominal wall, is usually best accomplished through a transverse initial skin incision.

In the past, transverse abdominal incisions have not found wide acceptance because they necessitate cutting across muscles in which sutures hold poorly and almost invariably cause tissue necrosis.

In the new technic of suturing transverse incisions, no attempt is made to suture muscle—only the surrounding sheath. Approximation of the muscle edges is further aided by keeping the patient in a semi-reclining position with knees partially flexed.

Because of the favorable results attending increasing use of this technic, and the current interest in principles which may facilitate early ambulation, D&G presents a series illustrating the incisions, and methods of suturing them.



1. For gall bladder, common duct, head of pancreas.
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*7. Small exploratory transverse incision.

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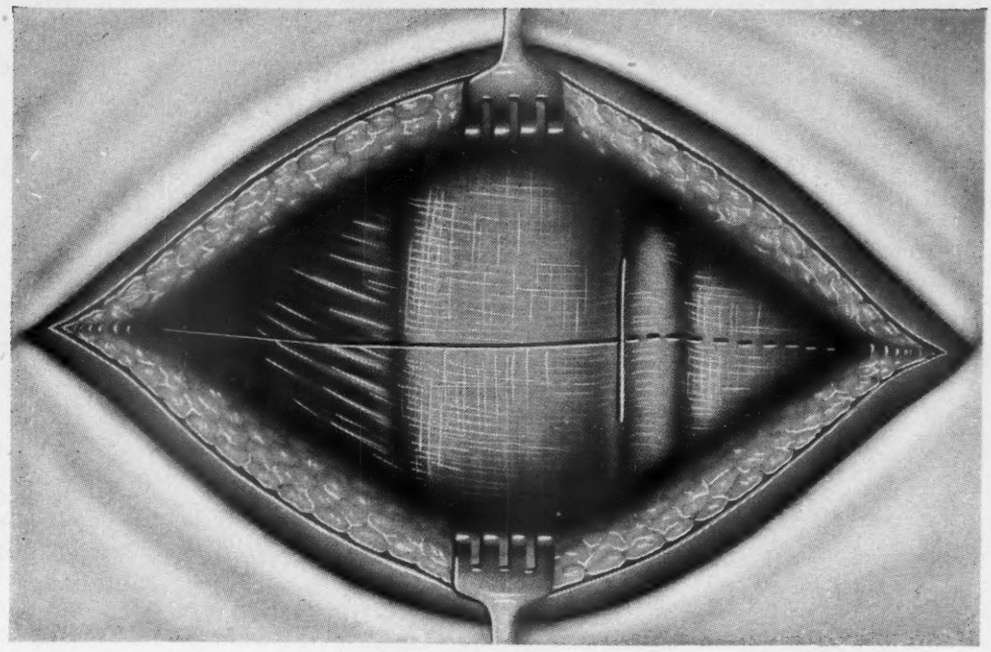
THIS small transverse incision in the epigastrium is useful for suturing the perforated peptic ulcer or for taking a biopsy of the liver. The muscles are not cut and they return to their original position. Hence the patient can be ambulated on the day after operation without fear of wound disruption.

After the skin incision is made, the recti are moved laterally either on one or both sides. To do this the anterior rectus fascia is cut and the muscles are freed in their sheath by blunt dissection. They are retracted laterally by loop retractors. Further lateral

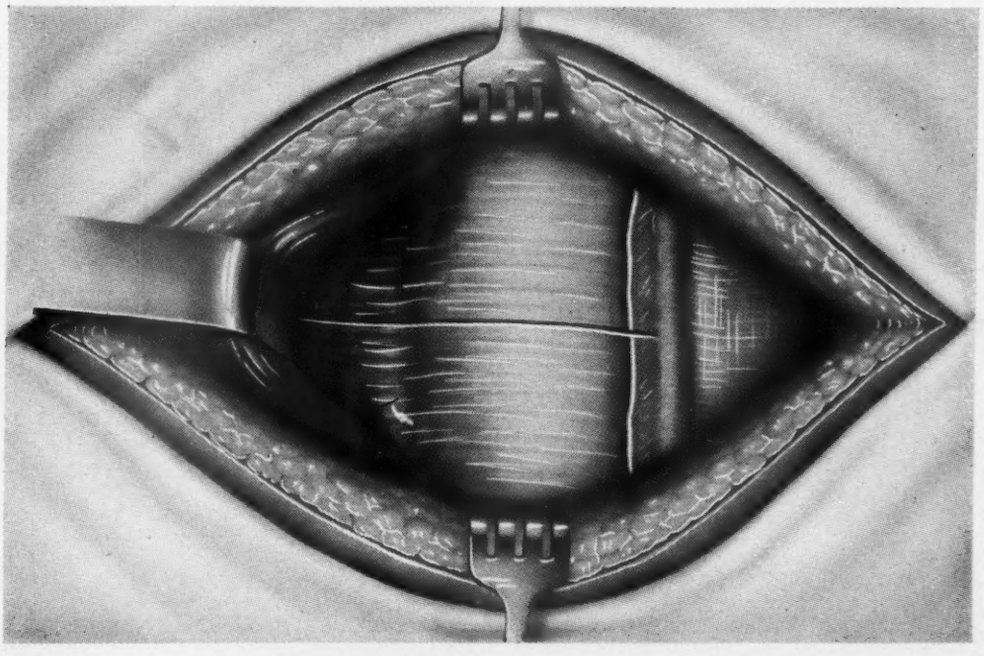
Wound Disruption

NUMBER SEVEN OF A SERIES



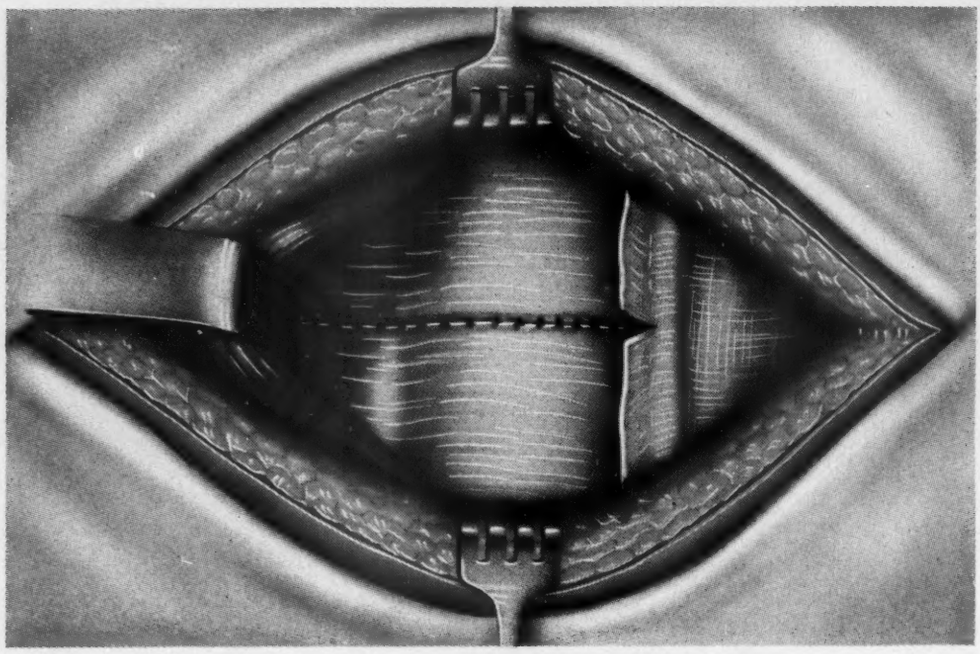
Incision in anterior rectus sheath. Longitudinal extension along medical border of rectus muscle.

mobilization of the muscle is obtained by incising the anterior rectus fascia cephalad near the midline. The procedure for doing this on the right side is shown. After the posterior rectus sheath and the peritoneum is divided the round ligament must be divided and ligated. If the exposure is not adequate, the incision can be converted into a complete transverse incision by cutting either or both recti.



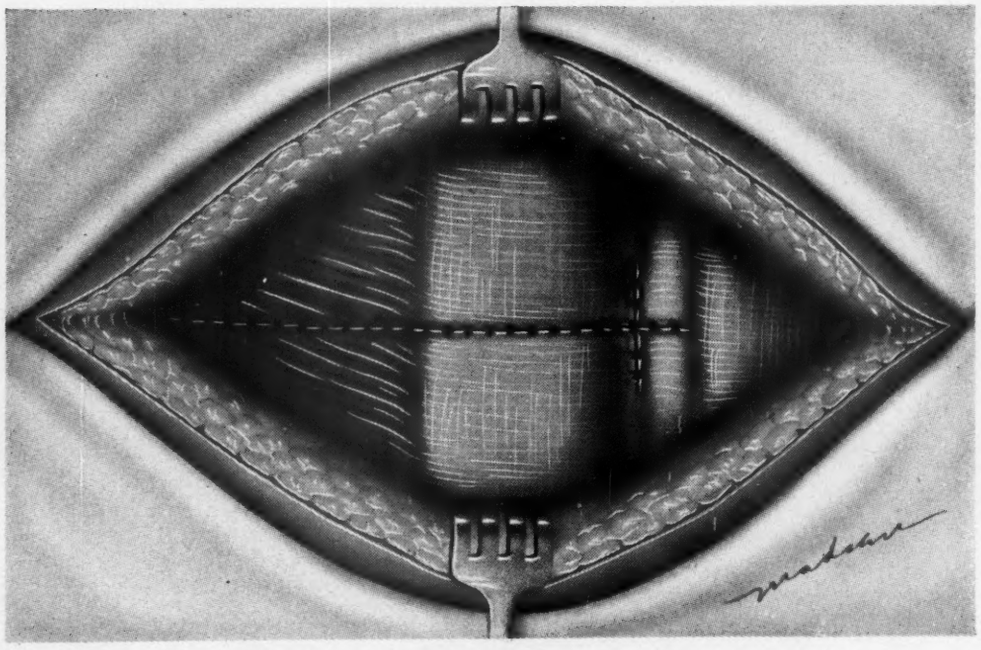
Incision posterior rectus sheath muscle retracted laterally.

Incisions that Minimize Wound Disruption



Sutured posterior rectus sheath and peritoneum.

Interrupted sutures are placed only in the posterior and anterior sheaths. The muscles are not sutured in the midline although the cephalad extension in the anterior rectus sheath may require one or two sutures. The skin is closed in the usual manner. (*Reprints of this series may be obtained on request.*)



Sutured anterior rectus sheath.

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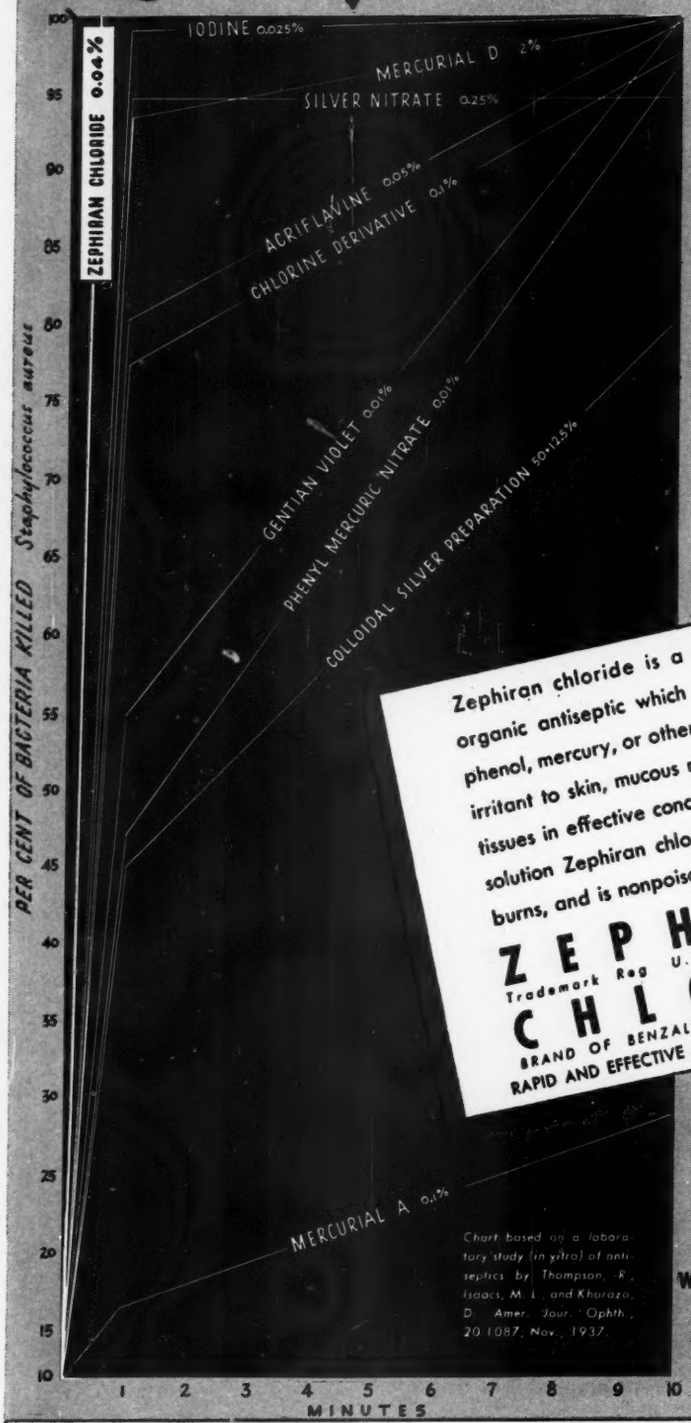

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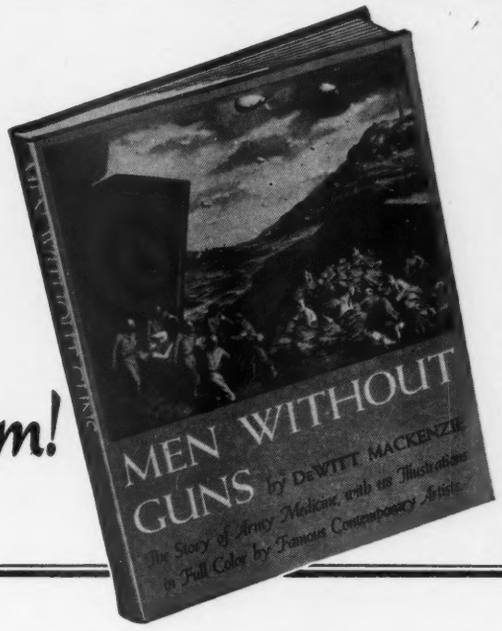
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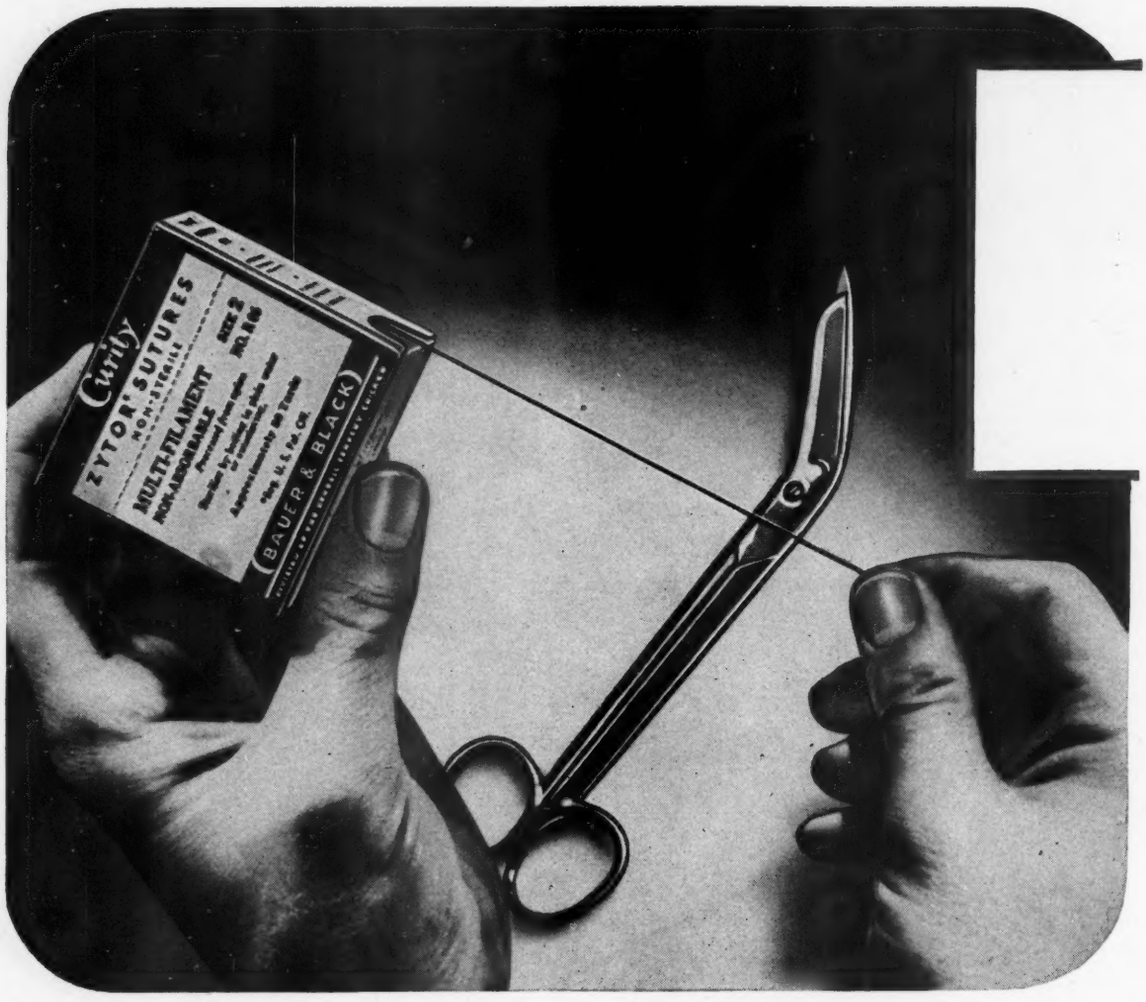

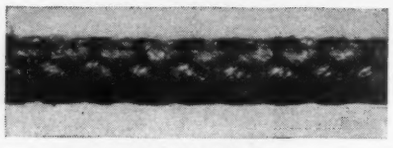

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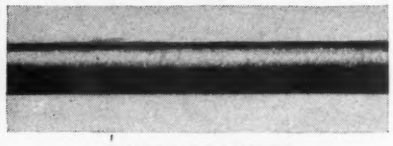

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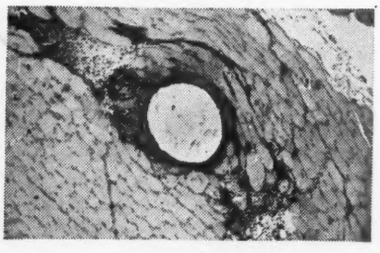

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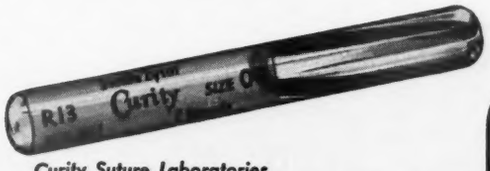

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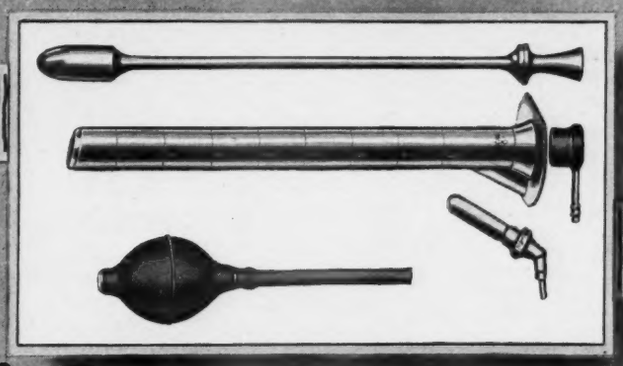

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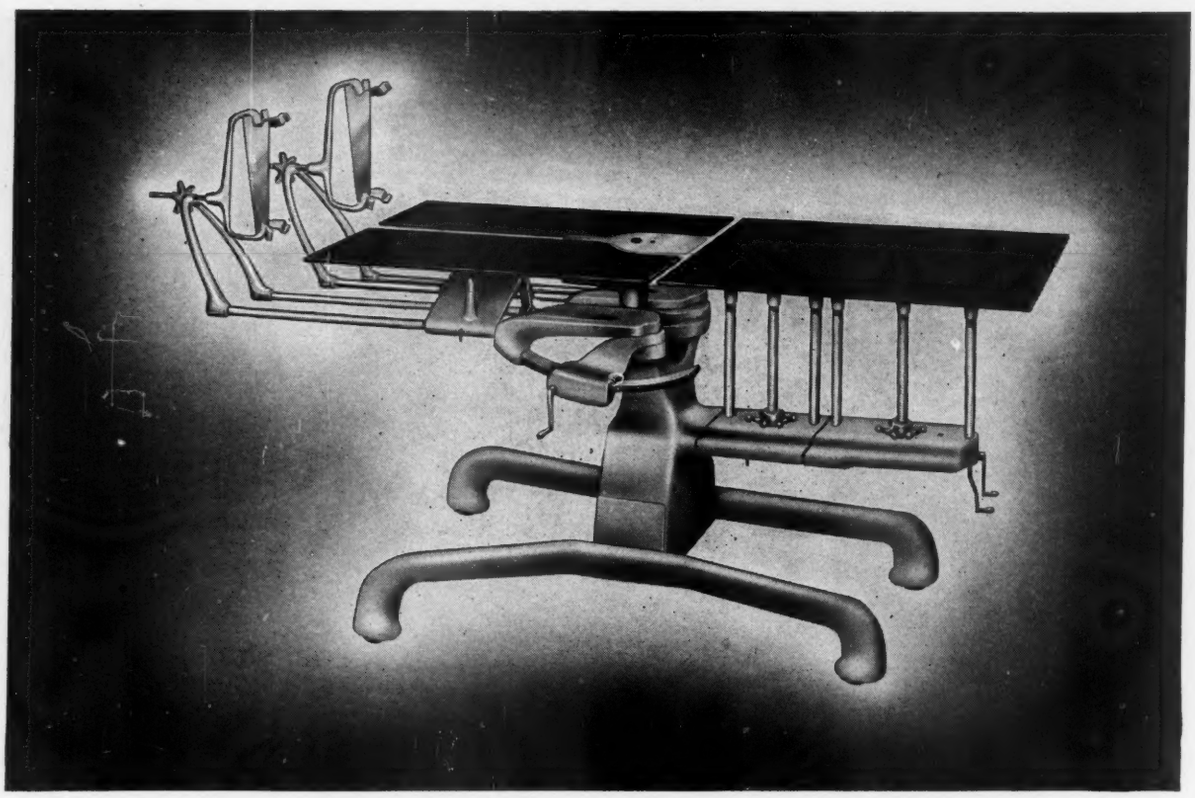

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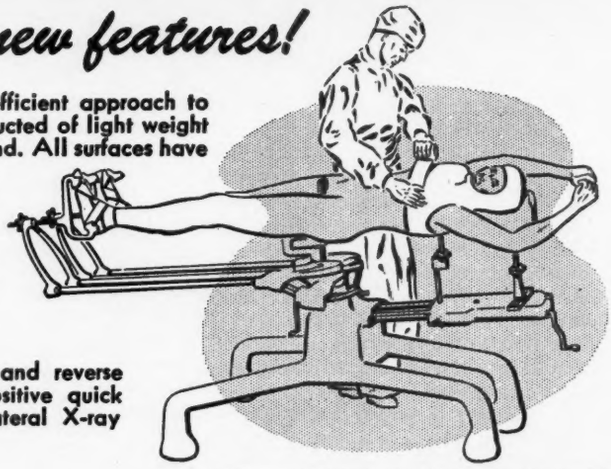

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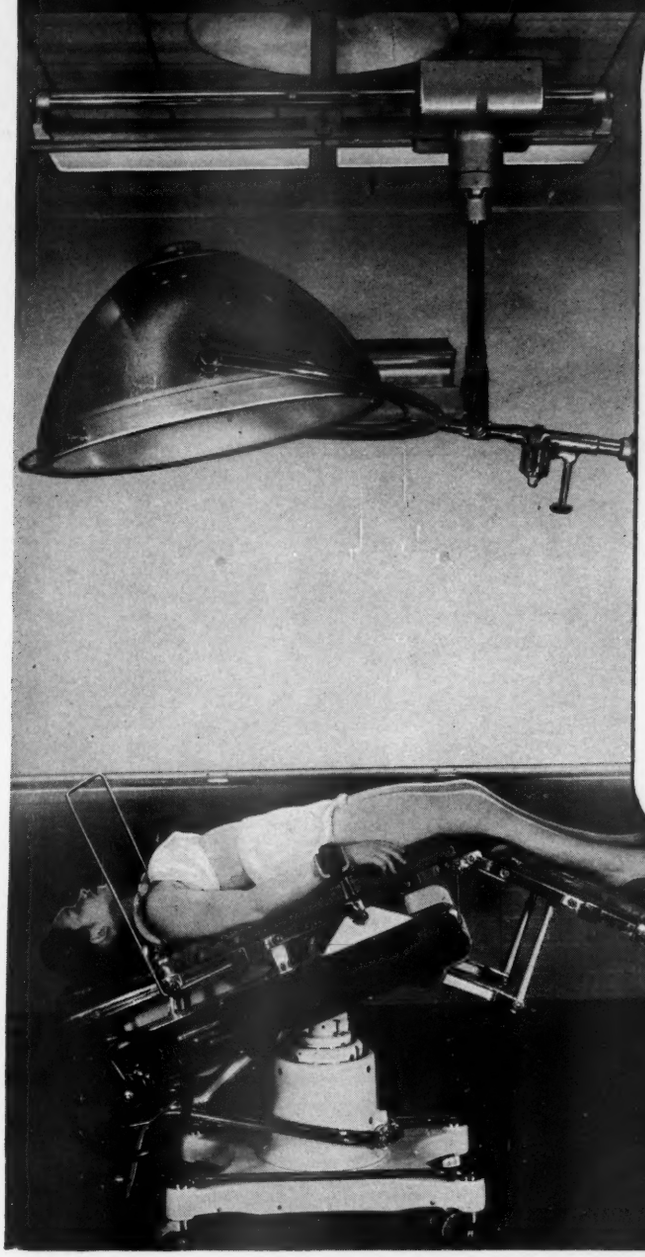
PRECISE SURGICAL POSTURING
. . . a timely consideration



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. . . for the first time . . .
affords these two outstanding advantages—

First– **The positioning of the patient in an infinite number of different surgical postures while safely immobilized under the anesthetic.**

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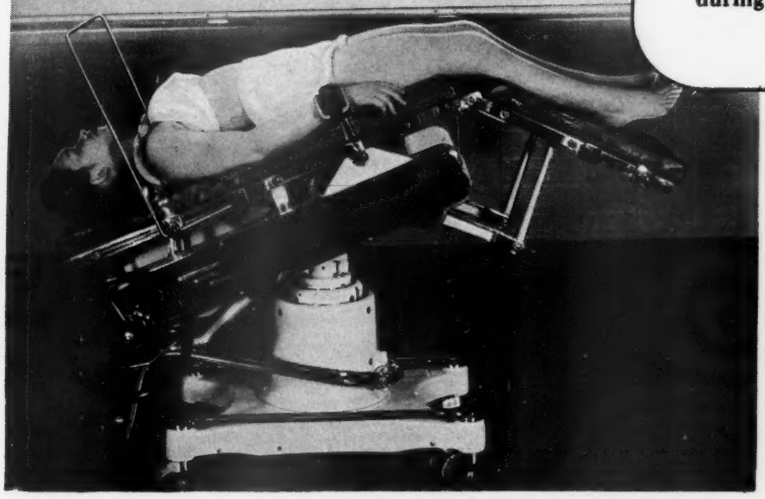

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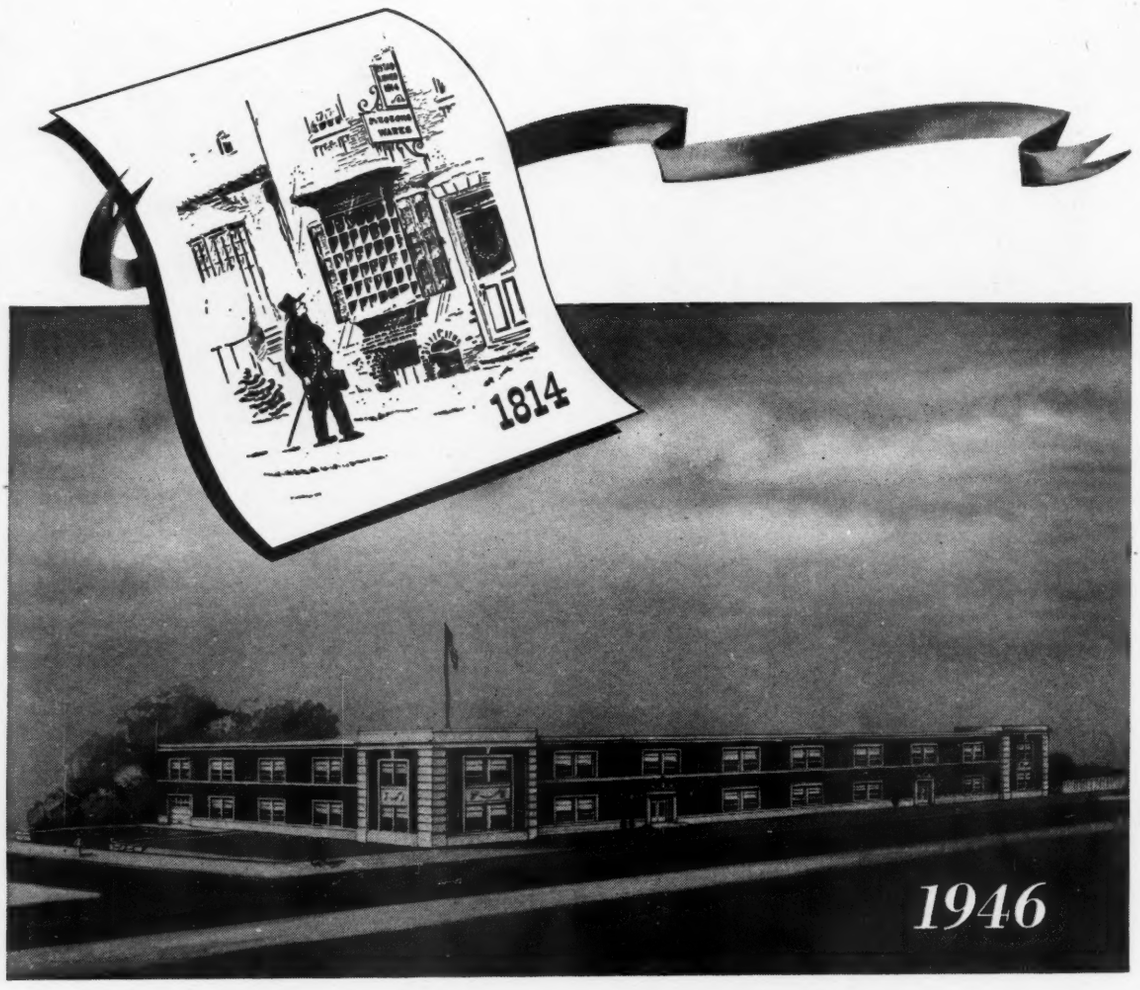

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...no PINS...no WIRES

• The Stone Hip Nailing Guide, as used in intra-capsular femoral neck fractures insures true direction and course of the nail without the insertion of pins, wires, or the trial and error method of introducing the nail.

No part of the guide apparatus enters the operating wound, thus reducing the hazard of infection.

The apparatus serves as direction finder and a guide in nailing and is VISIBLE throughout entire operation.

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— ARNETT, J. H.,
Am. J. of the Medical Sciences
205:6-8, Jan. 1943

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Indications: Local treatment of sulfonamide-susceptible infections of oropharyngeal areas; acute tonsillitis and pharyngitis; septic sore throat; infectious gingivitis and stomatitis; acute Vincent's disease.

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OBJECT: DEATH BY STARVATION

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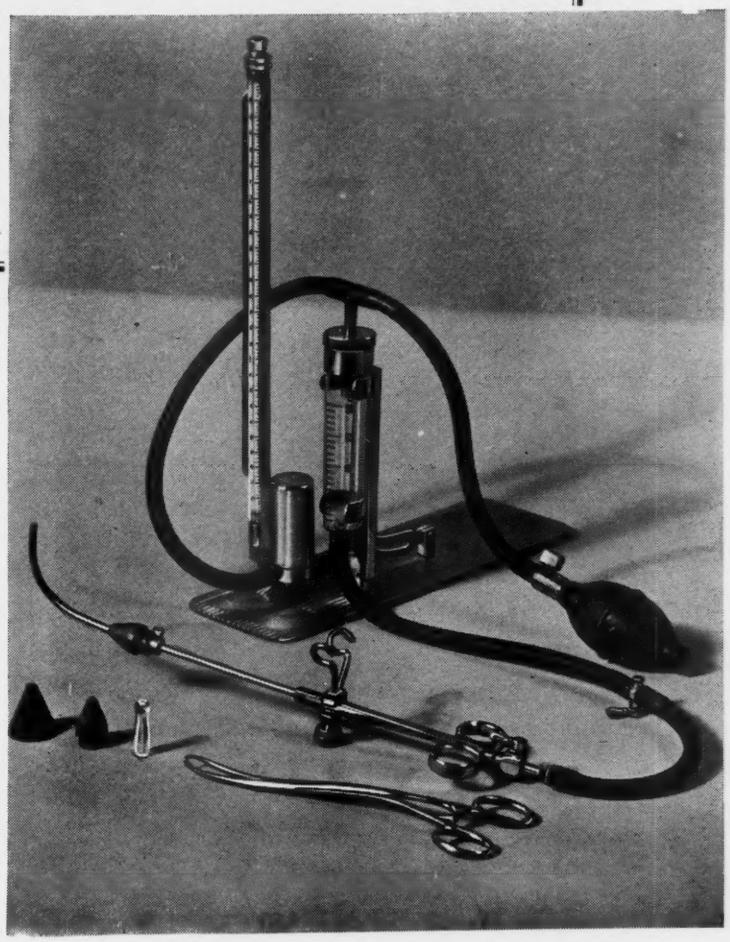

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As pressure is exerted between the manometer and the oil, contamination is effectively prevented. This is the only apparatus that operates in this manner.

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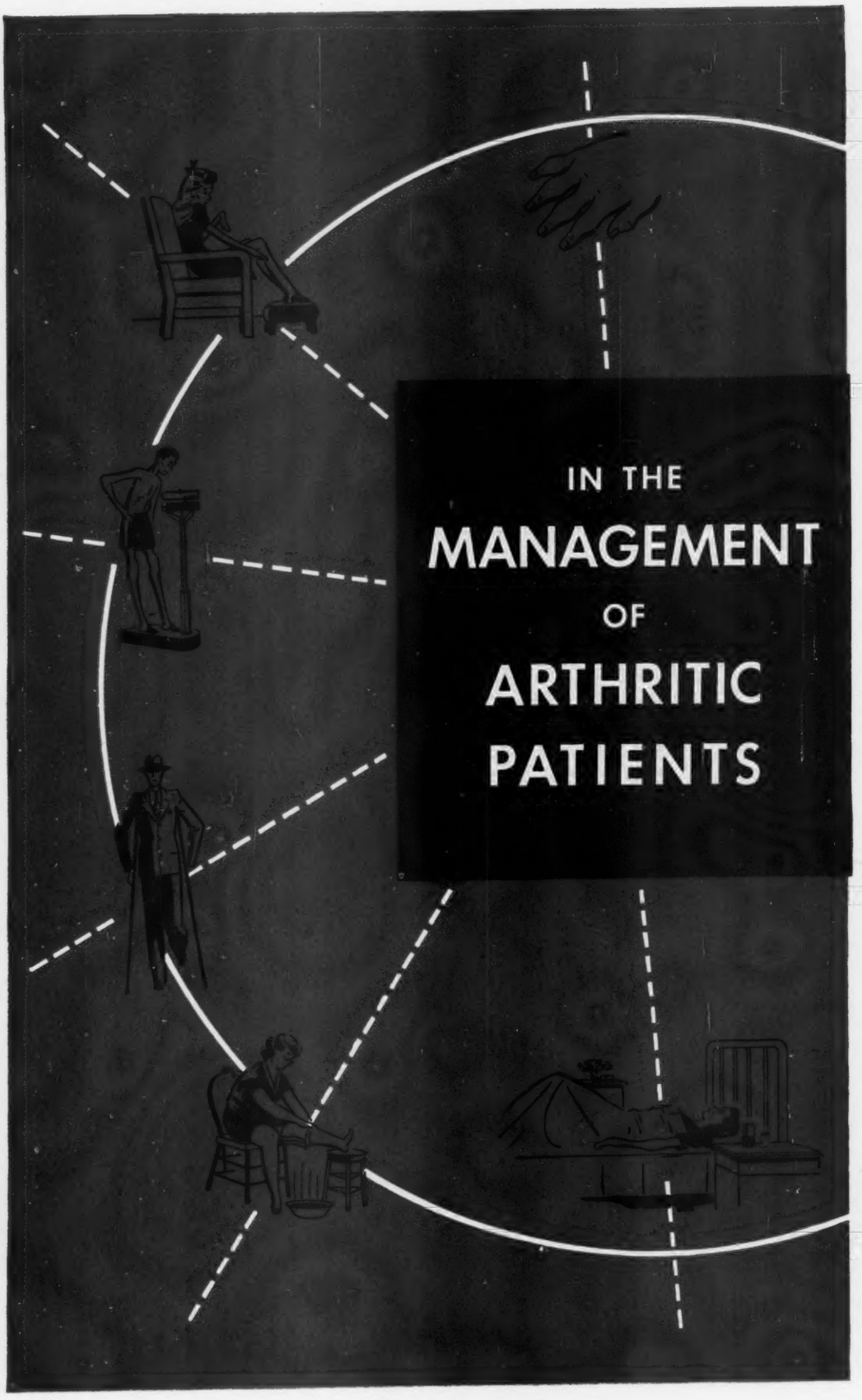
IN THE
MANAGEMENT
OF
ARTHRITIC
PATIENTS

* In the 1943 edition of *Nutrition and Diet in Health and Disease*, McLester emphasizes the importance of large amounts of all the essential vitamins in the treatment of chronic rheumatoid arthritis. He states that "Vitamins in abundance should be provided."

* *"Vitamins in abundance should be provided"*

Most rheumatologists recognize this need for all the vitamins, in addition to any specific requirement, in the management of the arthritides. Clinical investigations emphasize the systemic nature of chronic arthritis and reveal that better results were obtained when in addition to massive doses of vitamin D adequate amounts of the other vitamins were administered.

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(Equivalent in biological activity to 3 mg. of Alpha Tocopherol)	

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TOPICILLIN CHEWING TROCHES

20,000 units penicillin calcium in a flavored paraffin base, each troche individually wrapped. Box of 6.

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General purpose ointment containing 1,000 units penicillin calcium per gram in a base of petrolatum, anhydrous lanolin, beeswax and peanut oil. Tube of 14.5 Gm. (½ oz.)

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Penicillin calcium in peanut oil with beeswax, 300,000 units per cc. 1-cc. and 10-cc. vials.

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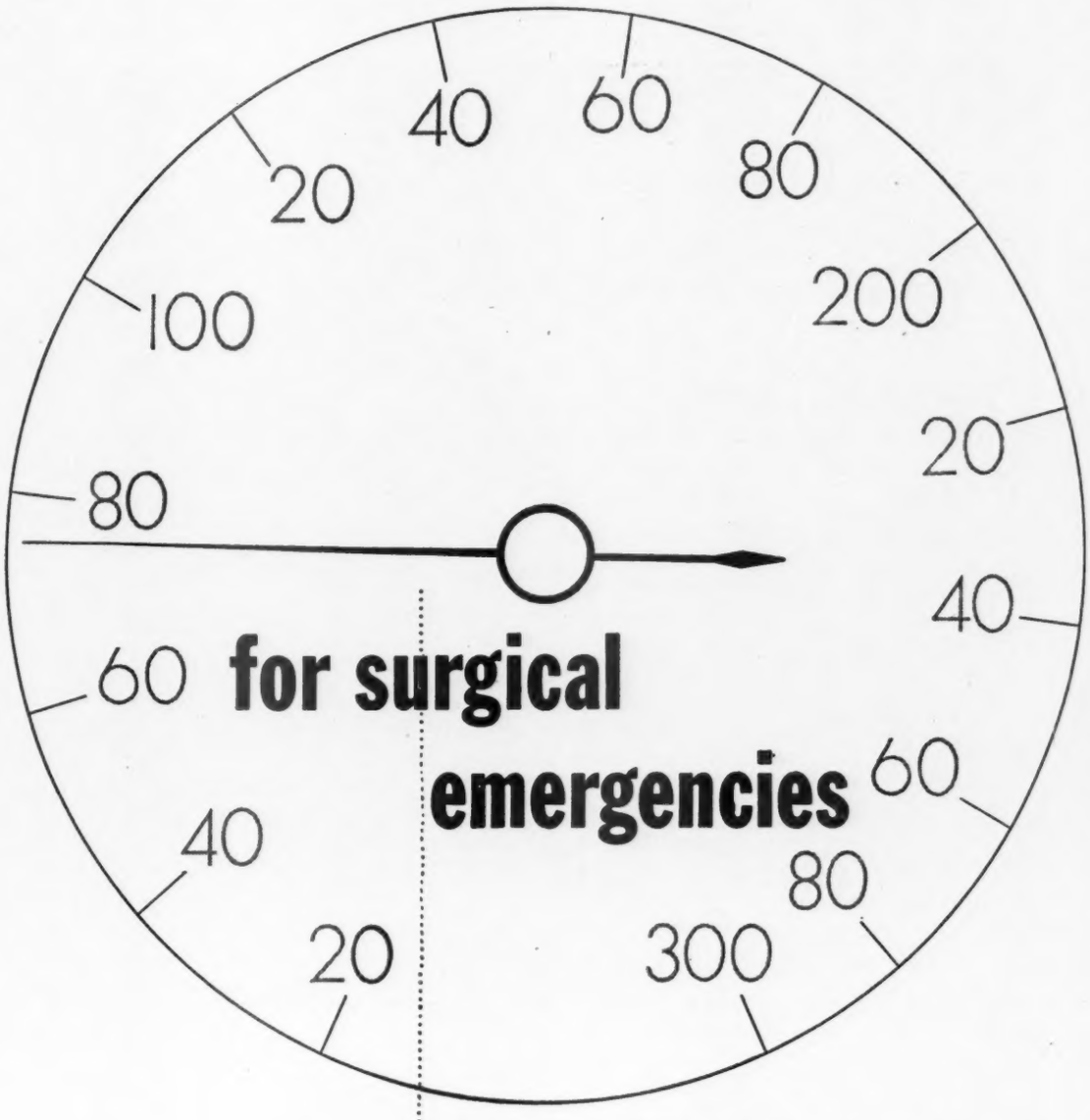

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a new vasopressor agent

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The intravenous route is recommended in surgical emergencies when the blood pressure falls to dangerous levels and an immediate response is imperative.

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INJECTION

20 mgm. in 1 cc. . . . Boxes of 6, 12 and 100 ampuls

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A Fundamental Approach
TO SULFUR METABOLISM

HYDROSULPHOSOL

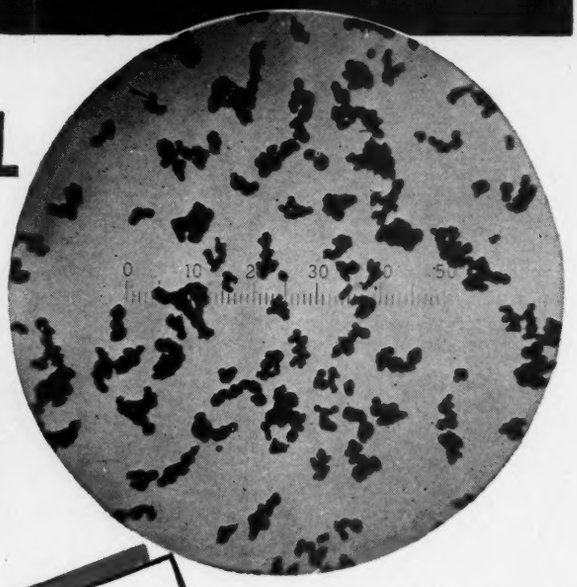

Illustration showing flowers of sulfur magnified 82X: small divisions = 10 microns. The size of the colloidal sulfur particle in Hydrosulphosol is estimated at 1/1000 of a micron or 1/10,000 of the small division particle illustrated.

A true solution of sulfur bearing compounds resulting solely from the reduction of flowers of sulfur by a catalytic process. In aqueous solution, it is capable of releasing its unusually high concentration of sulfhydryl ion in readily utilizable form . . . without evidence of toxic reaction.

Its therapeutic importance may best be evaluated by the fact that the —SH radical of the cysteine forms the active group in glutathione, alone of reported importance in connection with tissue oxidations.

Hydrosulphosol is indicated in the management of burns, ulcers and pathological conditions in which sulfur metabolism is a clinical consideration.

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Abundant clinical reports of its successful use testify not only to its value as a dependable hemostatic agent but add impressive evidence as to its non-toxicity.

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Third Degree

In severe thermal burns, when protein needs far exceed the limits of dietary toleration, Parenamine provides extra-dietary amino acids to restore and maintain positive nitrogen balance and correct hypoproteinemia.*

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For protein deficiency

PARENAMINE is a sterile 15 per cent solution of amino acids containing all known to be essential for humans, derived by acid hydrolysis from casein, fortified with pure *dl*-tryptophane

INDICATED in conditions of restricted intake, faulty absorption, increased need or excessive loss of proteins such as in preoperative and postoperative management, extensive burns, delayed healing, gastro-intestinal disorders, fevers, et cetera.

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SUPPLIED as 15 per cent sterile solution in 100 cc. rubber-capped bottles.

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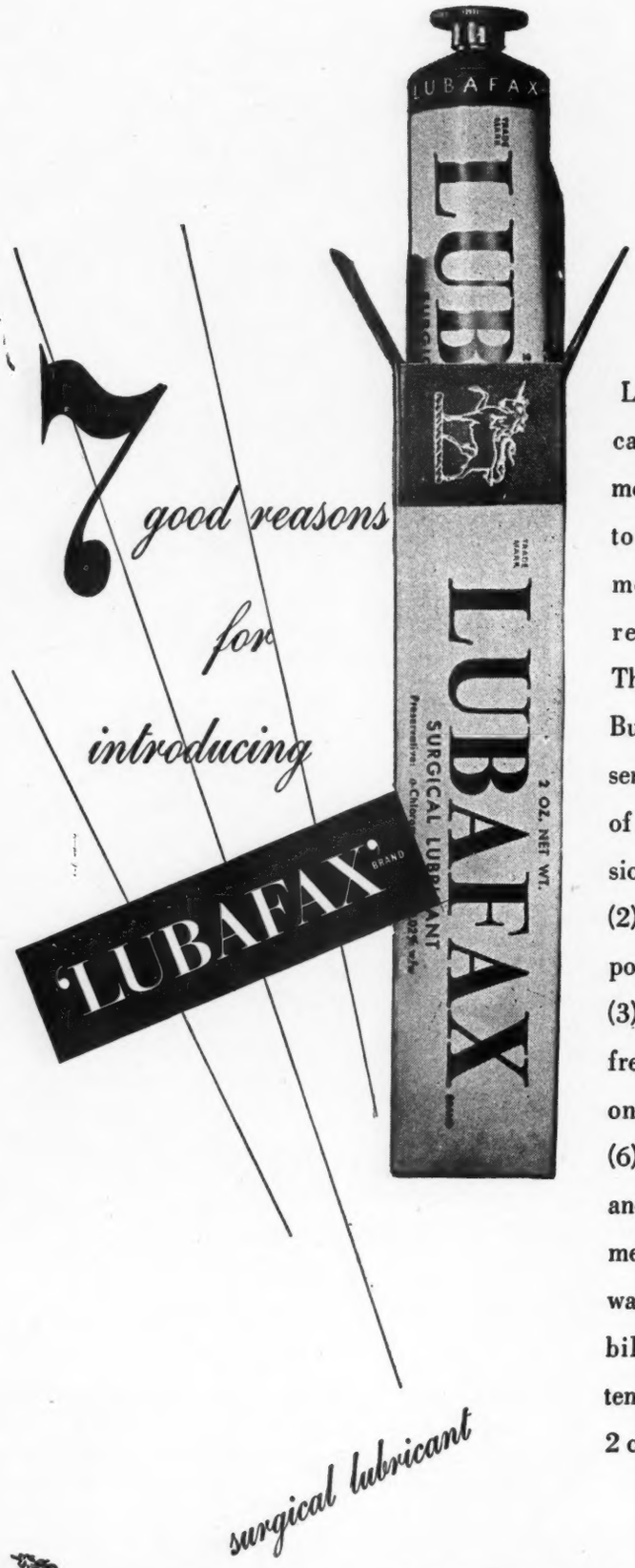

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"Childhood," to paraphrase G. B. Shaw, "is such a delightful period that it seems a shame to waste it on children." Yet, old age also may be delightful.

For those who remain young in heart, their spirit warmed by tender reminiscence, the advancing years pass gracefully. For others, these may be lean and bitter years of depression . . . the mind and body plagued by a host of minor ailments. Chronic constipation imposes a particularly oppressive burden.

Gentle yet effective management of constipation with 'AGAROL'* Emulsion brings welcome relief to those who were once young and gay; as well as to those who are still young . . . and should be gay.

For additional pharmaceutical details consult your pharmacist—for more extensive medical data write Medical Division of William R. Warner & Co.

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'agarol'

Emulsion of mineral oil and an agar-gel with phenolphthalein. Supplied in bottles of 6, 10 and 16 fluidounces.

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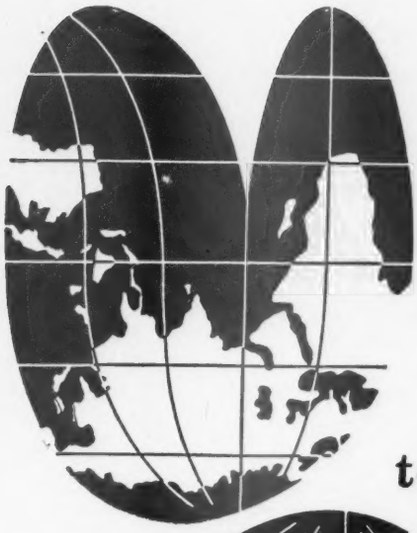

terra firma

The management of hemorrhoids rests on solid therapeutic grounds when it achieves relief without resort to dangerous local narcotization or anesthetization. 'ANUSOL'* Hemorrhoidal Suppositories contain neither anesthetic nor narcotic agents and so do not mask the symptoms of more serious rectal pathology. Quick, safe relief is attained by the removal of inflammatory pressure on the nerve endings. Burning and itching are soothingly abated while demulcent protection guards against the complications of bleeding and infection.

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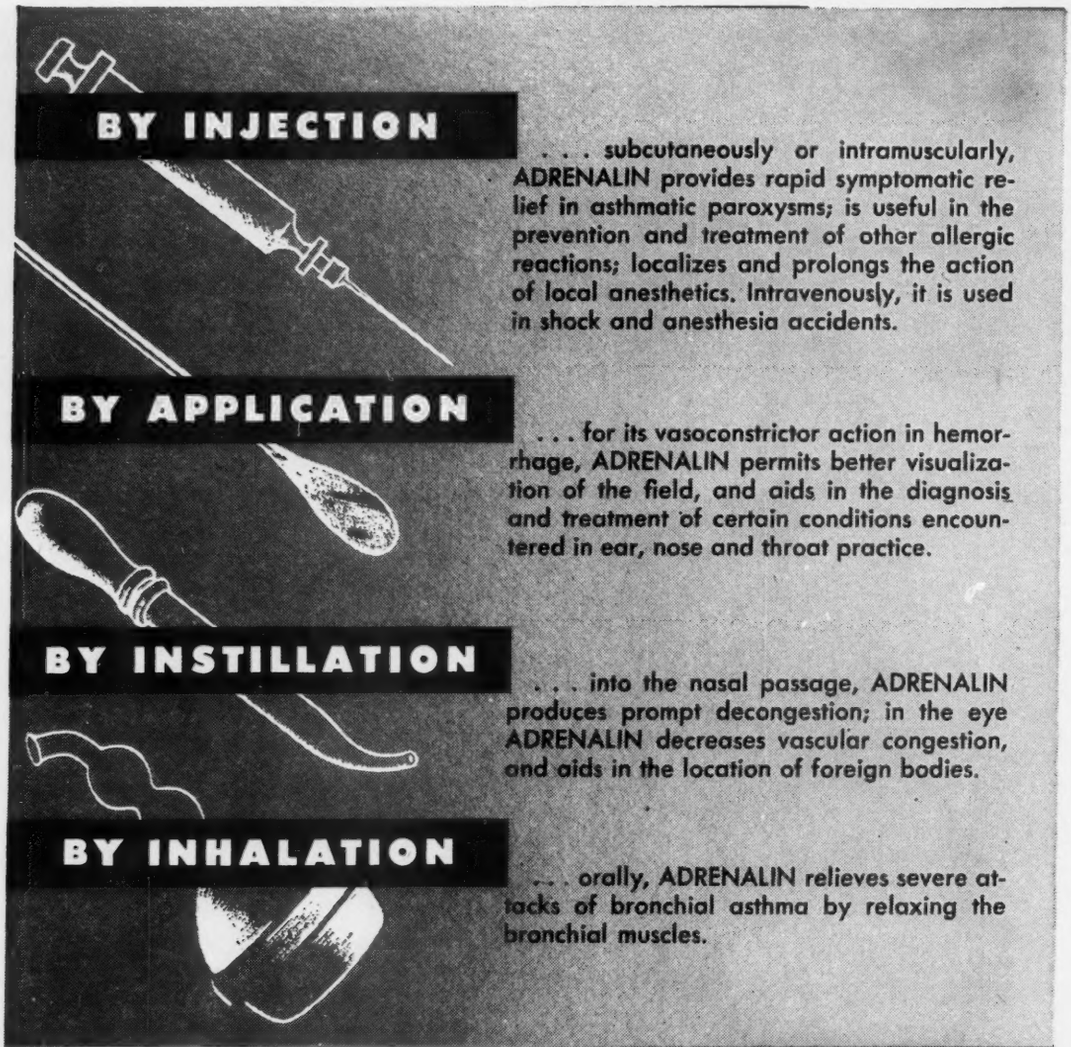
Boxes of 6 and 12 suppositories

Hemorrhoidal Suppositories



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. . . subcutaneously or intramuscularly, ADRENALIN provides rapid symptomatic relief in asthmatic paroxysms; is useful in the prevention and treatment of other allergic reactions; localizes and prolongs the action of local anesthetics. Intravenously, it is used in shock and anesthesia accidents.

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. . . into the nasal passage, ADRENALIN produces prompt decongestion; in the eye ADRENALIN decreases vascular congestion, and aids in the location of foreign bodies.

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Its remarkable ability to stimulate the heart and increase cardiac output, raise the blood pressure, constrict the peripheral arterioles, dilate blood vessels of voluntary muscles, and relax bronchial muscles . . . makes ADRENALIN one of the most *versatile* and *useful* therapeutic agents at the command of the physician. Little wonder, then, that it's always kept close at hand in operating room, office, and medical bag.

To permit full use of its many therapeutic applications, there is a form of ADRENALIN (Epinephrine) to meet every medical need: Solutions of 1:100, 1:1000, 1:2600, 1:10,000; Suspension of 1:500 in oil; and Inhalant, Suppository, and Ointment.

ORIGINAL ADRENALIN

PARKE, DAVIS & COMPANY

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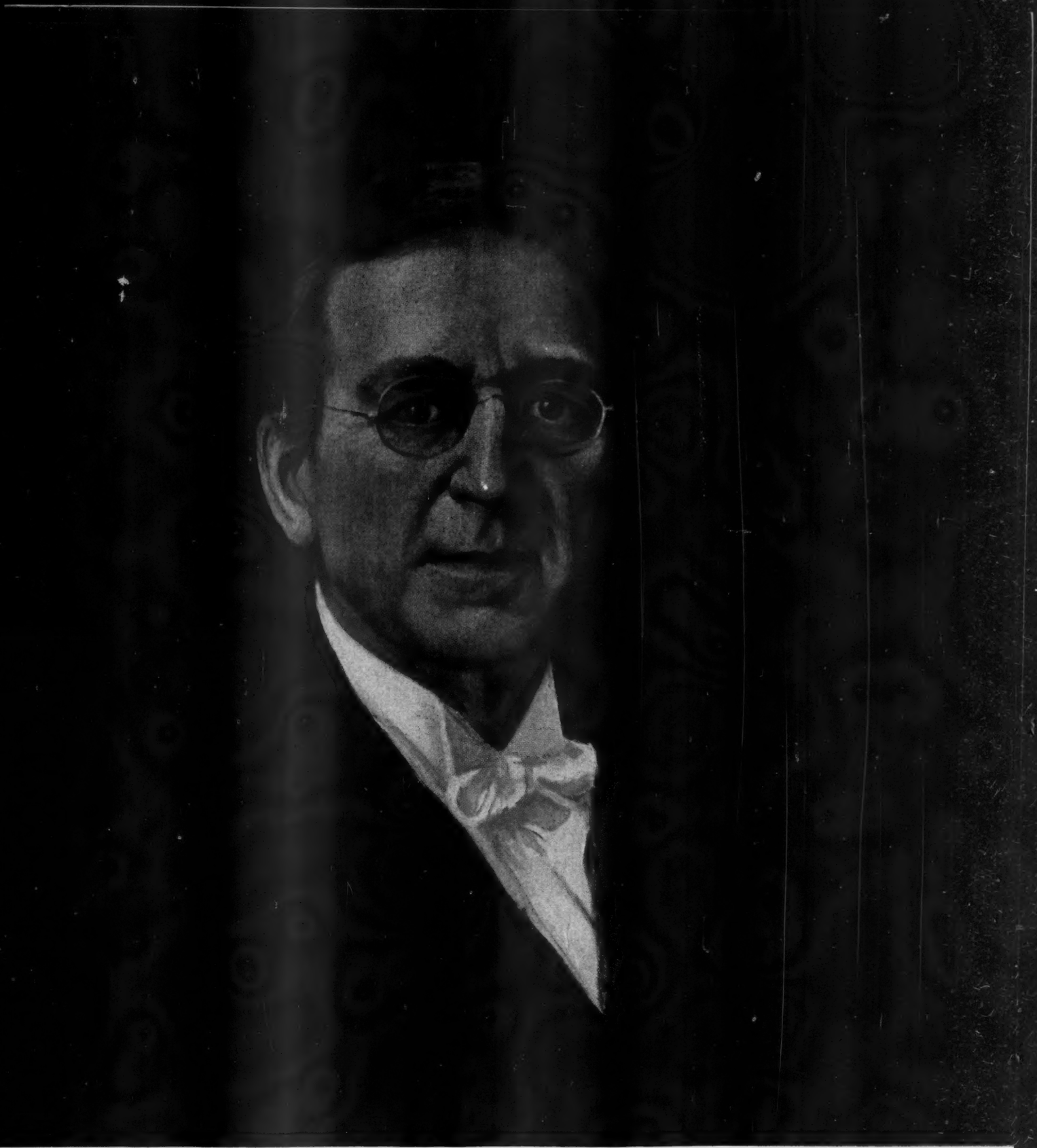

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COURTESY, AMERICAN COLLEGE OF SURGEONS

Albert J. Ochsner

1858-1925

Renowned Surgeon, Diagnostician, and Educator. Instructor in Surgery, Rush Medical College, 1889-1895; Professor of Clinical Surgery, University of Illinois College of Medicine, 1900-1925; Surgeon-in-Chief, Augustana Hospital, 1891-1925, and St. Mary's Hospital, 1896-1925; President, Clinical Congress of Surgeons of North America, 1910-1912; a Founder, Regent, and Treasurer, American College of Surgeons; President, 1923-1924; President, American Surgical Association, 1924; Winner of Gold Medal, Louisiana Purchase Exposition, 1904.

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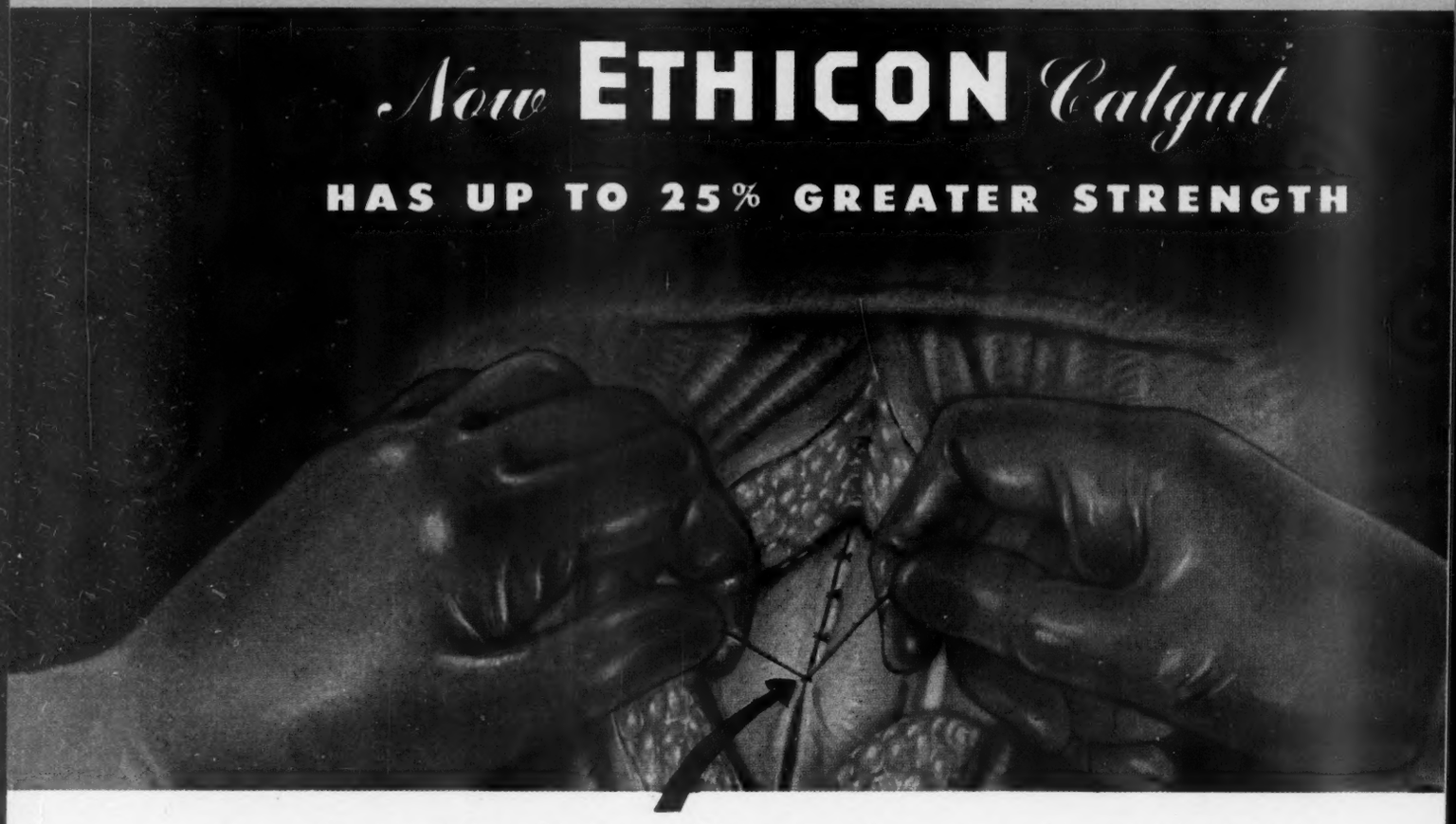
ETHICON SUTURE LABORATORIES, DIVISION OF JOHNSON & JOHNSON, NEW BRUNSWICK, N. J.

NEW ACHIEVEMENTS FROM

Now ETHICON *Catgut*

HAS UP TO 25% GREATER STRENGTH



Knot-Breakage Further Minimized

Suture strength is most essential to the surgeon when the knot is being tied. This is the time of greatest strain. Ethicon's increased strength will aid in further reducing knot breakage.

● Here are 3 new contributions to your surgical technic:

1. Knot-breakage reduced by increased tensile strength.

2. Foreign body reaction reduced. Many surgeons will find smaller sizes adequate.

3. Catgut now usable in many new situations, with the smallest sizes ever made (6-0 and 5-0).

INCREASED STRENGTH

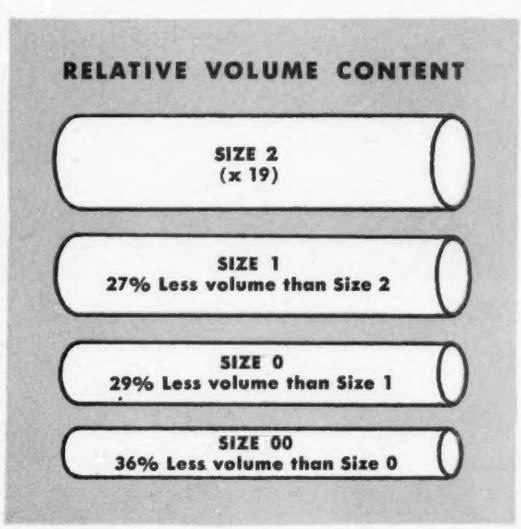
New exclusive processes developed by the Ethicon Laboratories have resulted in increases in tensile strength as high as 25% greater than any other catgut suture meeting U.S.P. diameter specifications.

Knot breakage is further minimized. The amount of pull exerted in knot-tying varies widely among surgeons. Those whose technic makes maximum demands on a suture's strength will have less breakage with the new, stronger Ethicon strands.

USE SMALLER SIZES—REDUCE REACTION

It is now generally accepted that the greater the amount of suture material embedded the greater is the tissue reaction.

Smaller sizes of catgut retain their integrity longer than larger sizes. The larger the suture, the greater the increase in phagocytosis and enzymatic digestion. The smaller sizes arouse decidedly less foreign body reaction, hence they maintain their integrity longer.



Foreign Body Reaction Reduced. The above chart shows possible reductions in amounts of suture material embedded in tissue when smaller sizes are used.

ETHICON'S LABORATORIES

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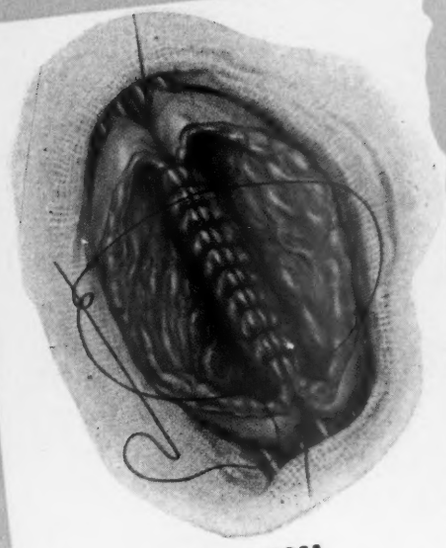

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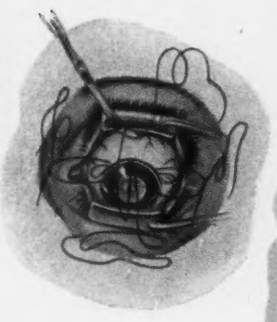

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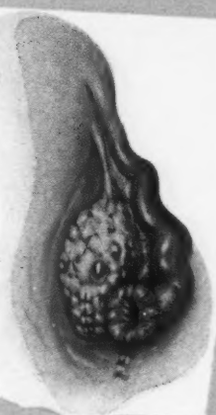

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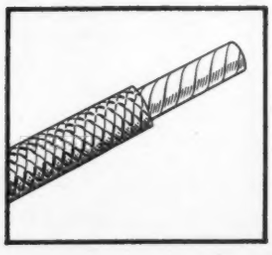

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A PRACTICAL JOURNAL BUILT ON MERIT

Fifty-fifth Year of Continuous Publication

VOL. LXXI JANUARY, 1946 NUMBER ONE

Editorial

NINETEEN FORTY-SIX

PERHAPS it is well that one cannot look into the future and fortell coming events. The war is over, the world is in a turmoil, and many problems, readjustments and threats confront our profession. Some headaches started before the war; others were born during the conflict; a new set began with demobolization.

No one questions the wonderful work done by those of the medical profession while in uniform. The system, started prior to hostilities, of training young graduates for their future work resulted in the saving of thousands of lives, and also in returning more thousands of our service men to civilian life physically and mentally robust, who otherwise may have been human wrecks for months or years. Because of the system of medical education, intern and resident training, and teamwork, these medicos accomplished more "miracles" than did the sulfa drugs, penicillin and plasma. All thinking men hope this system, interfered with and knocked galley-west during the war, will be permitted to resume where it left off, and not have a set of arm-chair bureaucrats inaugurate a lot of new theories hardly in the blueprint stage. All interested in medical education will welcome back the established four-year medical course with summer vacations, a boon to both students and teachers. We understand this will come after this year. A move in the right direction was evidenced by a directive of the Procurement and Assignment Service, Washington, D. C., when recently they ordered that . . . "Hospitals . . . must begin at once to appoint veterans [of this war] to every staff position so that, with rare exceptions, every militant resident can be called to active duty not later than April 1, 1946 . . . " In other words, the great majority of our house-men after April 1st will be from the ranks of the honorably discharged veterans of this latest war.

We (and many others) have heard and received letters from physicians in service who complain they are not being released with speed and dispatch. Many of our newspapers have filled columns on this topic. For the duration the civilian population suffered from a depleted medical profession. Many of these not-too-young men who have serviced three or four years, the majority married and the fathers of children, complain they are the victims of a rigid and too high point system, and are twiddling their thumbs and suffering from boredom in far away outposts. By the time this is in print we hope we'll hear that these loyal medical citizens will be in the process of swiftly being returned to civilian life.

Our hospitals rendered excellent service to their communities during the war years. Without exception they worked overtime

and at full bed capacities with skeleton staffs of nurses, maids, porters, and other personnel. Right here a bouquet to The American Red Cross for the aid and service they gave to our hospitals during these trying times! They supplied volunteer nurses-aids, dieticians, clerks, telephone operators and other personnel to their full ability. It is hoped that many of our nurses will return soon to their old posts, and that before long our hospitals will be adequately staffed.

Recently, President Truman offered a "Plan" which he says is not Socialized Medicine. We read and heard over the radio (Dr. Fishbein) the claim that the "Plan" IS Socialized Medicine. Whatever the outcome we hope that we, as physicians, will not get it "in the neck" and have to labor under a system dominated by politicians and stuffed shirts who "yield to no man, etc. . . . "

Publishers and editors of scientific journals have not escaped the war years. Confronted with a serious paper shortage, government rules and restrictions, and with so many physicians in uniform and out of the country, the task of publishing a quality journal month after month has not been an easy one. But with the Peace [sic] we hope soon to get back on a prewar schedule. Even at this early date we note an increase in the number of articles submitted for publication, and an increasingly greater number are of a high order of merit. One day we trust we will find it possible greatly to increase our yearly number of text pages. We have two Special Numbers in the making for 1946, and we hope to be able to afford more color. We intend sticking to our policy of selecting only articles that impart practical knowledge and that stimulate thought and prove valuable to the reader. That we are on the right track is evidenced in our circulation and our distribution, for we are read in every country in the world.

And so for the year 1946 it is hoped that many of our problems will be solved to our satisfaction, that our young men will be provided with means to receive the added training they need (especially true for the "3 year hurry-up group), that large funds will become available for real medical research, that the medical colleges and hospitals will quickly get back to normal, and that before the buds come out on the trees over ninety-five per cent of our physicians, now in uniform, will have been honorably discharged and back in their offices, hospitals or laboratories.

To you all for 1946, best wishes for health, contentment and peace.

T. S. W.

Original Articles

THE PHYSICK-SELLHEIM PRINCIPLE OF EXTRAPERITONEAL CESAREAN SECTION

ELUCIDATION OF A TECHNIC BASED ON 175 CASES

JAMES V. RICCI, M.D. AND JAMES P. MARR, M.D.
NEW YORK, NEW YORK

THE purpose of this article is primarily to portray the essential steps of the Physick-Sellheim principle of extraperitoneal cesarean section. A review of the literature on this subject reveals a type of illustration which has neither clarified the operation nor aided the operator in his initial trials. Before any of the present drawings were made, the artist, Mr. Alfred Feinberg, witnessed several operations in order to obtain an adequate knowledge of the anatomic structures involved and to absorb the operator's point of view.

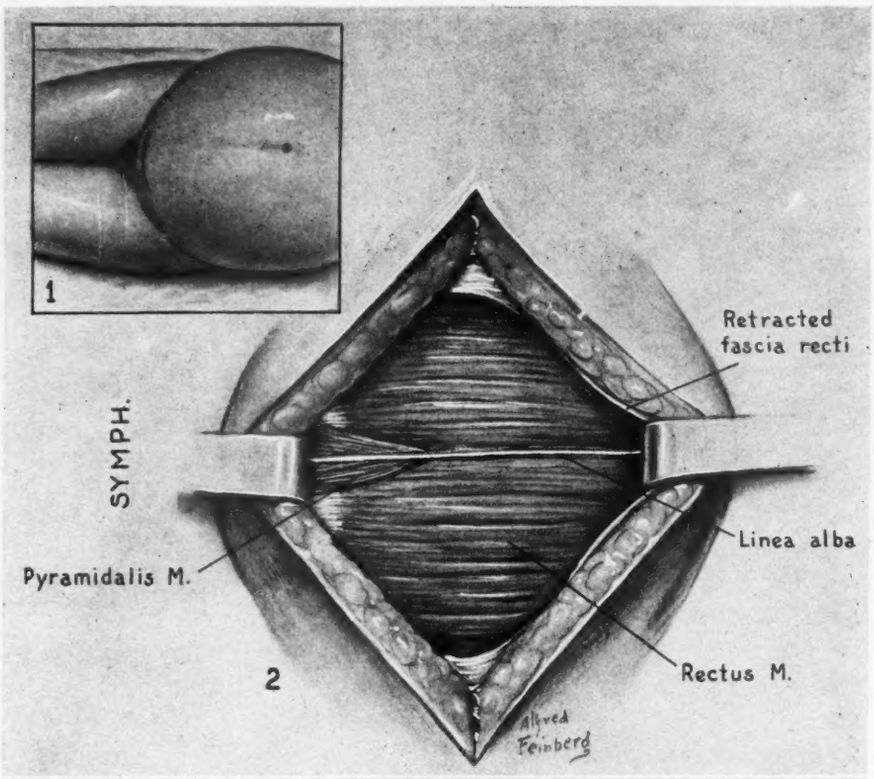
The technic to be described has been used, with slight variations, in 175 cases. The extraperitoneal procedure was not always indicated. This series includes instances wherein the operation was performed on surgically "clean" cases and even on non-laboring parturients. But it also includes a large number of patients in prolonged labor and with ruptured membranes, some of which had been subjected to unsuccessful vaginal instrumentation—in brief, patients commonly referred to as potentially or actually infected.

From a surgical point of view, a true candidate for an extraperitoneal cesarean must be considered below par. Prolonged labor, particularly a poorly sedated or unsedated painful labor, leads to physical exhaustion and dehydration. The added ordeal of an excessively long surgical procedure (even though extraperitoneal) may predispose the patient to certain hazards—surgical shock and postoperative uterine hemorrhage. Shock may occur on the operating table or immediately thereafter, while hemorrhage may develop following the cessation of styptic controls. To prevent shock, the usual preoperative infusions of saline, plasma and blood are held in readiness. Prolonged labor and prolonged inhalation anesthesia diminish the efficacy of uterine contractility. On this basis, adequate uterine packing is strongly advocated. In instances of unsuccessful attempts at vaginal instrumentation leading to possible trauma of the presenting cervical lip, or even lower segment, the added precaution of vaginal packing is also advisable.

Deaths. There was one death which was preventable in this series of 175 cases. It occurred in a small private sanitarium, with inadequate and incompetent intern supervision. The patient died of exsanguination, approximately sixteen hours after leaving the operating room in excellent condition. When first seen in the early hours of the morning, the patient was *in extremis*. No blood was available. To avoid a similar catastrophe, all cesarean patients should be grouped prior to operation, and bank blood should be available at a moment's notice.

Vesical Injuries. The bladder dome was opened in four instances and the posterior wall (of the bladder) was injured on two occasions. The dome injuries

FIGS. 1 AND 2.



FIGS. 3, 4 AND 5.

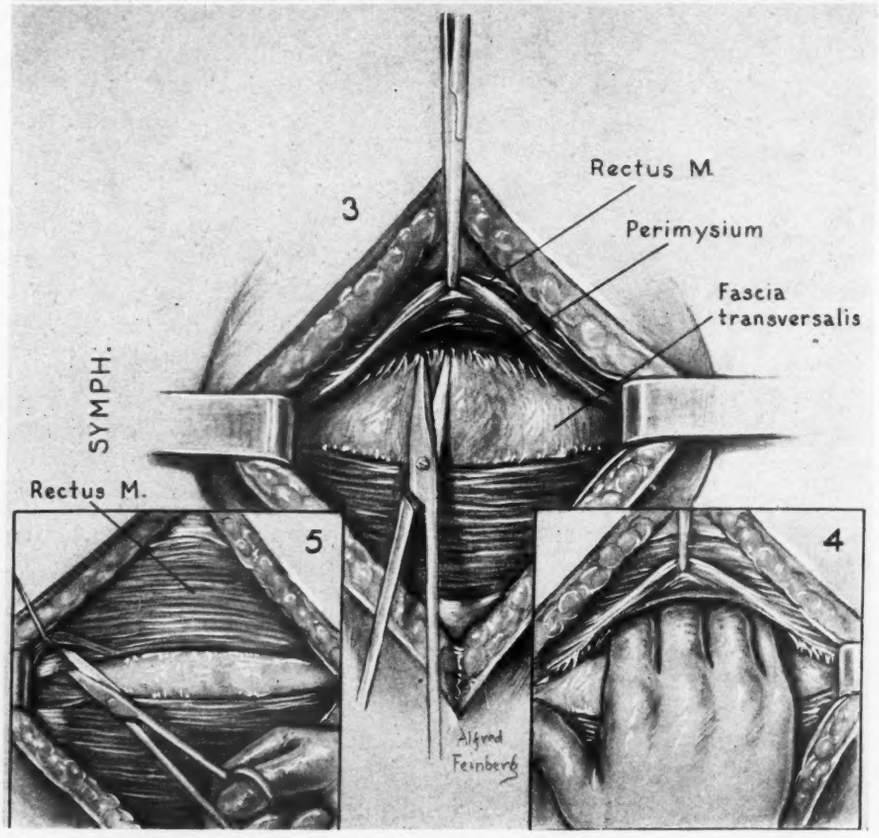


FIG. 1. Crescentic incision five inches long in the suprasymphyseal fold.

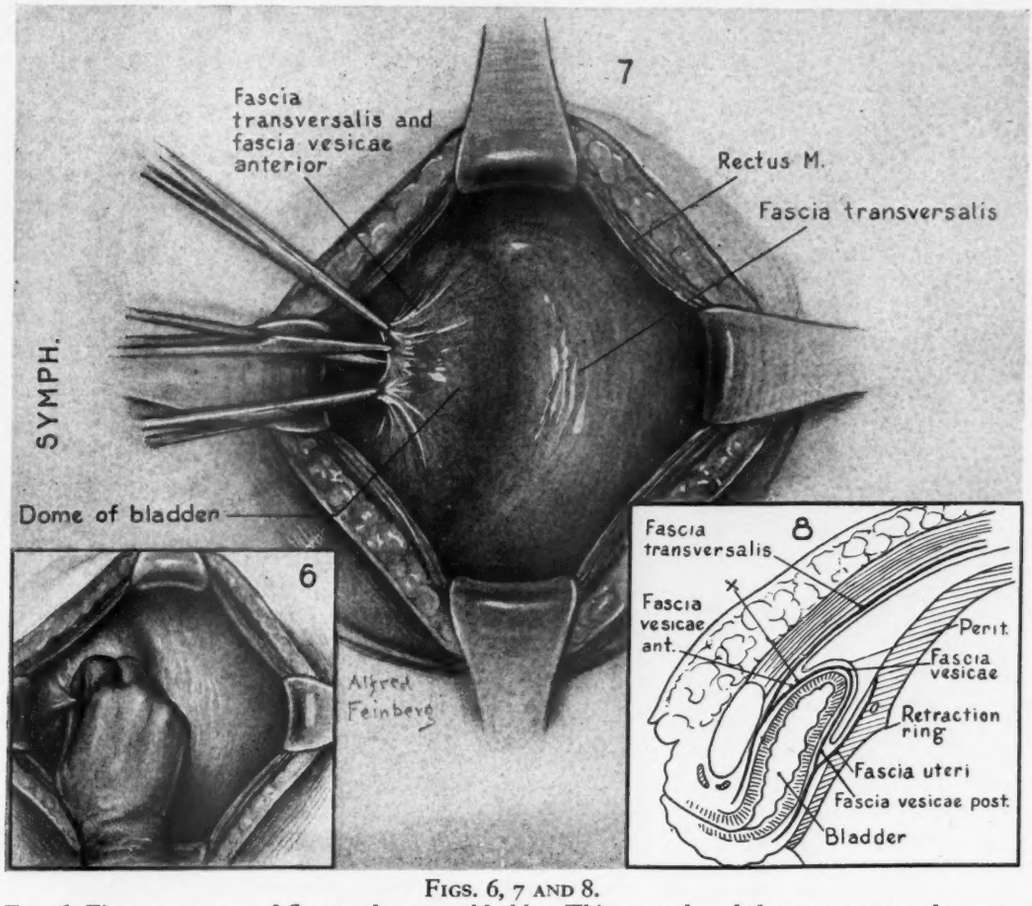
FIG. 2. Recti, pyramidalis muscles and linea alba.

FIG. 3. Cutting strands of perimysium between rectus muscle and fascia transversalis.

FIG. 4. Liberating of rectus muscle from the transversalis by a fan-shaped swing of the hand from symphysis to umbilical area.

FIG. 5. Cutting of the medial insertion fibers of both recti directly above the symphysis to facilitate lateral displacement of the recti and increase spaciousness of operative field.

usually occurred at the vesical-urachus area. The openings were small and easily managed. The rents in the posterior wall of the bladder were fully two inches long. One occurred in a patient who had been subjected to a previous laparotrachelotomy. Here, the bladder was found unyieldingly adherent to the lower segment. The other occurred in a patient traumatized by inexperienced instrumental attempts at vaginal delivery. In this case, the lower segment was discolored by extravasated blood so that fascial identification was found difficult and a rent of the bladder musculature resulted. The mucosal lining, which appeared intact, was injured while completing the bladder displacement. In all instances, repair was followed by an uneventful recovery without any lengthening of the hospital stay. In two other instances, no bladder injury was noticed at the time of operation, but an ammoniacal odor appeared on the dressings for several days. Injuries to the dome of the bladder, or even injuries to the upper half of the bladder (above the ureteral orifice), must not be considered too serious if adequate repair is instituted. Here the simple but fundamental surgical principles must be followed: raw surfaces must be accurately approximated by two layers of sutures without strangulation of tissues, and the "bite"



Figs. 6, 7 and 8.

Fig. 6. Finger massage of flattened, empty bladder. This procedure helps to contract the anesthetically relaxed bladder musculature and to loosen viscus from fascial capsule.

Fig. 7. Grasping and incising of fascia transversalis and fascia vesicae anterior one inch below bladder dome, exactly in mid-line. Both fasciae are laminated. Terminal lamination on bladder musculature is left to facilitate decapsulation and protect vesical vessels.

Fig. 8. Peritoneal and fascial relationships to bladder and lower segment exactly in mid-line. Cross (x) indicates point of incision of fascia transversalis and fascia vesicae anterior as portrayed in Figure 7.

must include sufficient tissue to guarantee adequate blood supply to the sutured parts. In instances of bladder dome injury, the small opening may be managed. It can best be repaired by grasping the edges, twisting them, tying and anchoring the suture by

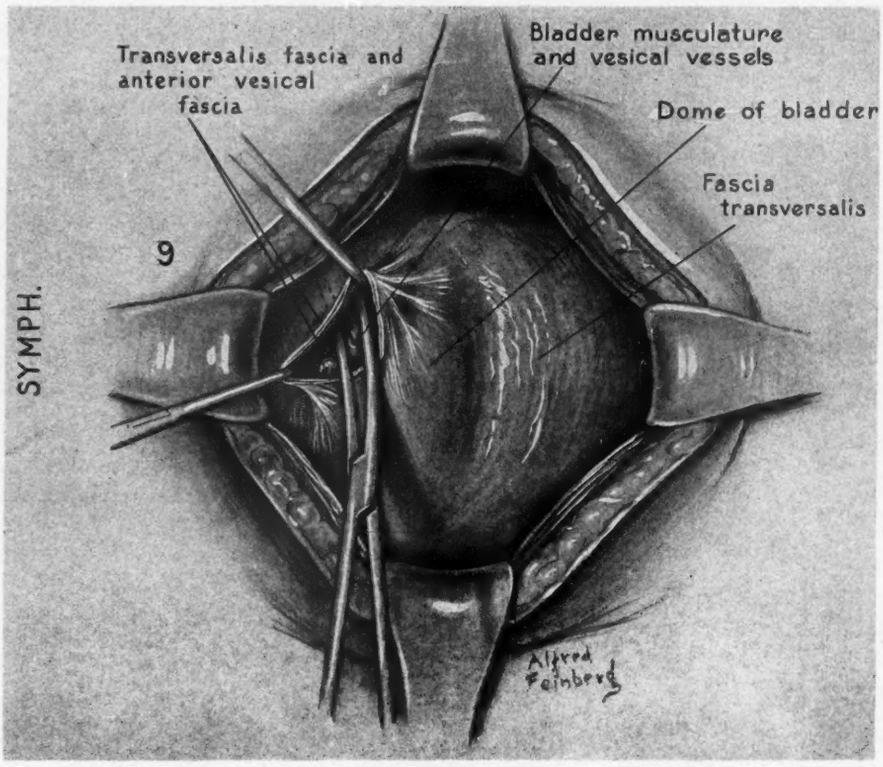


FIG. 9. Fascia transversalis and fascia vesicae anterior incised down to a terminal lamination covering musculature of bladder and vesical blood vessels. The cut margins of these two fasciae are portrayed as separate layers. *In vivo*, they appear as *one structure*. With a curved Kelly and in a fan-shaped swing, these fasciae are liberated from anterior surface of bladder, particularly from the lateral walls and the dome of the bladder. Index finger may be used instead of clamp. At the lateral walls of the bladder, this instrument pierces the anterior vesical fascia as it swings to envelope the posterior surface of the bladder, where it becomes the posterior fascia vesicae. The anterior peritoneal fold lies in a jacket between the transversalis fascia above, and posterior vesical fasciae below.

patients were catheterized every three hours. In posterior wall injuries, an indwelling catheter was utilized for four days and after it was removed the patient was catheterized every three to four hours. When there is frequent catheterization or an indwelling catheter is used, urinary antiseptics are administered.

Peritoneal Injuries. In the earlier trials of this series, the peritoneum was frequently injured. However, in this type of cesarean, injury to the peritoneum must be considered a serious breach of technic. Strictly speaking, once the peritoneum is "holed," the operation ceases to be a true extraperitoneal cesarean. Nonetheless, a passing the needle above the tie. Complete liberation of the peritoneal fold is then necessary to avoid loosening of the tie and extension of the peritoneal opening during the actual delivery.

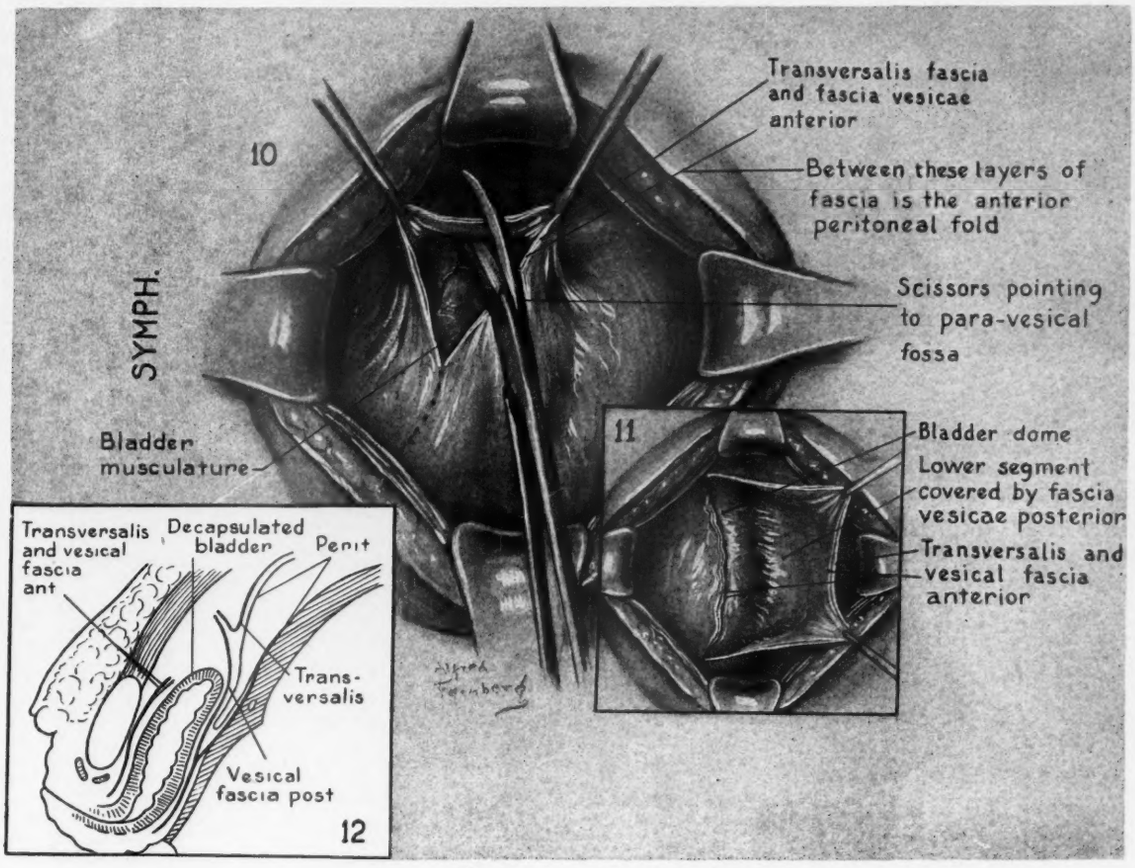
Fetal Deaths. There were only seven fetal deaths. Autopsy was performed in four; in one case, there was an adrenal hemorrhage, in two, congestion of the brain and emphysema of the lungs, and in the fourth one, an intracranial hemorrhage. One was a monster with hydrocephalus.

Phlebitis. There were three cases of phlebitis. In one case, the swelling of one extremity persisted for many months.

Despite these complications, a success-

fully executed extraperitoneal operation, finished well within an hour, presents several distinct advantages in immediate

Technical Minutae and Anatomic Considerations. Examine anesthetized patient vaginally on the operating table. Dislodge



FIGS. 10, 11 AND 12.

FIG. 10. Cutting of the fasciae (transversalis and anterior vesical). Scissors curve downward to the para-vesical fossa. This incision is made to right and left.

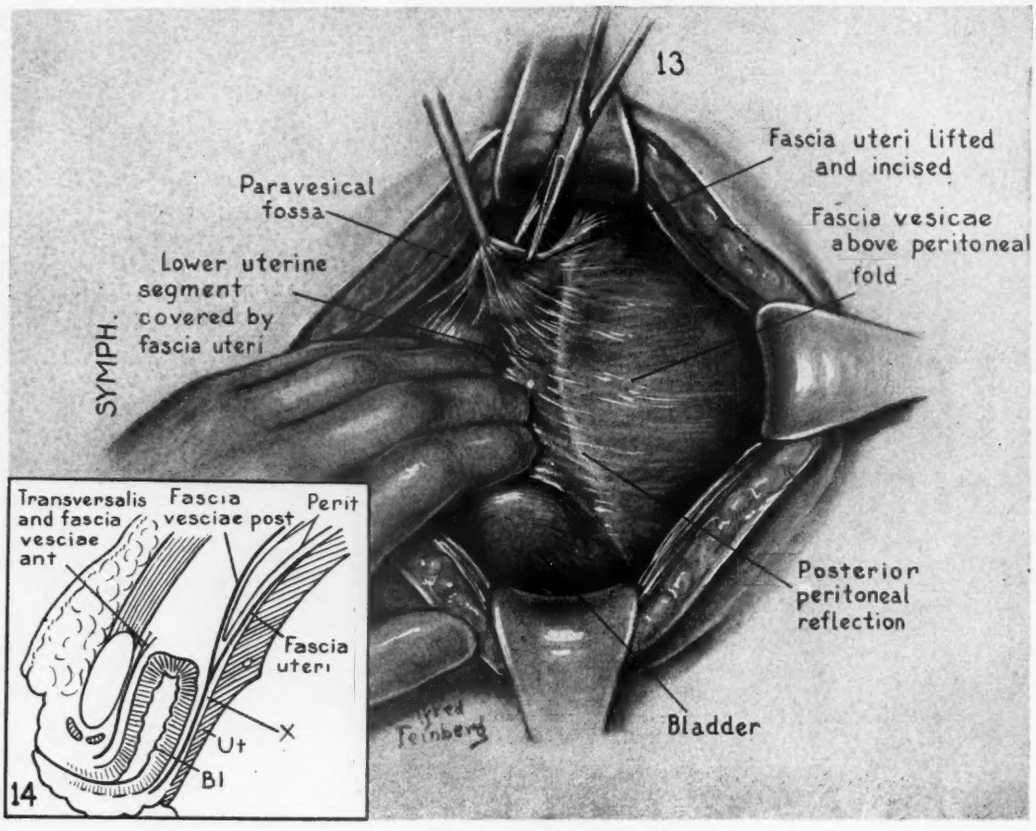
FIG. 11. Elevation of upper cut edges of fasciae (transversalis and anterior vesical). Between these two fasciae lies the anterior peritoneal fold, liberated from the anterior surface of the bladder and bladder dome.

FIG. 12. Diagrammatic presentation of Figure 11, exactly in mid-line showing the relationship of the fasciae (transversalis and anterior vesical) after being incised and liberated from anterior surface of bladder and bladder dome.

postoperative reactions over all intra-abdominal procedures. Voiding without catheterization is the rule. This is probably due to bladder manipulation during the operation, which counteracts the anesthetic muscular relaxation. Abdominal discomfiture and distention, if present, are transient and not distressing. The need for morphia is reduced. Fluids and food are relished a few hours after the operation. Cleansing the lower bowel the day following the operation hastens the feeling of comfort and well being.

an impacted fetal head in order to facilitate delivery. Pack the vagina with two inch iodoform gauze if the cervix is stumpy, uneffaced and "low." The delineating catheter, originally introduced to outline the bladder, has been completely eliminated. A completely empty bladder facilitates the operation and reduces bladder injury to a minimum. Place patient in a moderate Trendelenburg position. A five and one-half inch Pfannenstiel incision is made following the course of the supra-symphyseal fold. For accuracy and sym-

metry, locate the mid-abdominal point, eyeing the umbilicus as a guide. Make both arms of the incision symmetrical in length and curvature. Skin protection is advisable. Incise the aponeurosis of the recti and the oblique muscles with a pronounced curvature; cut median *raphe cephalad* a distance of three and one-half inches; and *pedad* down to the edge of the symphysis. Sever the median tendinous insertion fibers of the recti at the symphysis to facilitate lateral deviation of the recti muscles. The pyramidals need not be disturbed. These initial laparotomy steps bring the operating field into view.



FIGS. 13 AND 14.

FIG. 13. The paravesical fossa (right) is exposed to present lateral wall of bladder, the end of the posterior peritoneal fold and the fascia uteri. The posterior peritoneal fold lies between the posterior vesical fascia above, and the fascia uteri below.

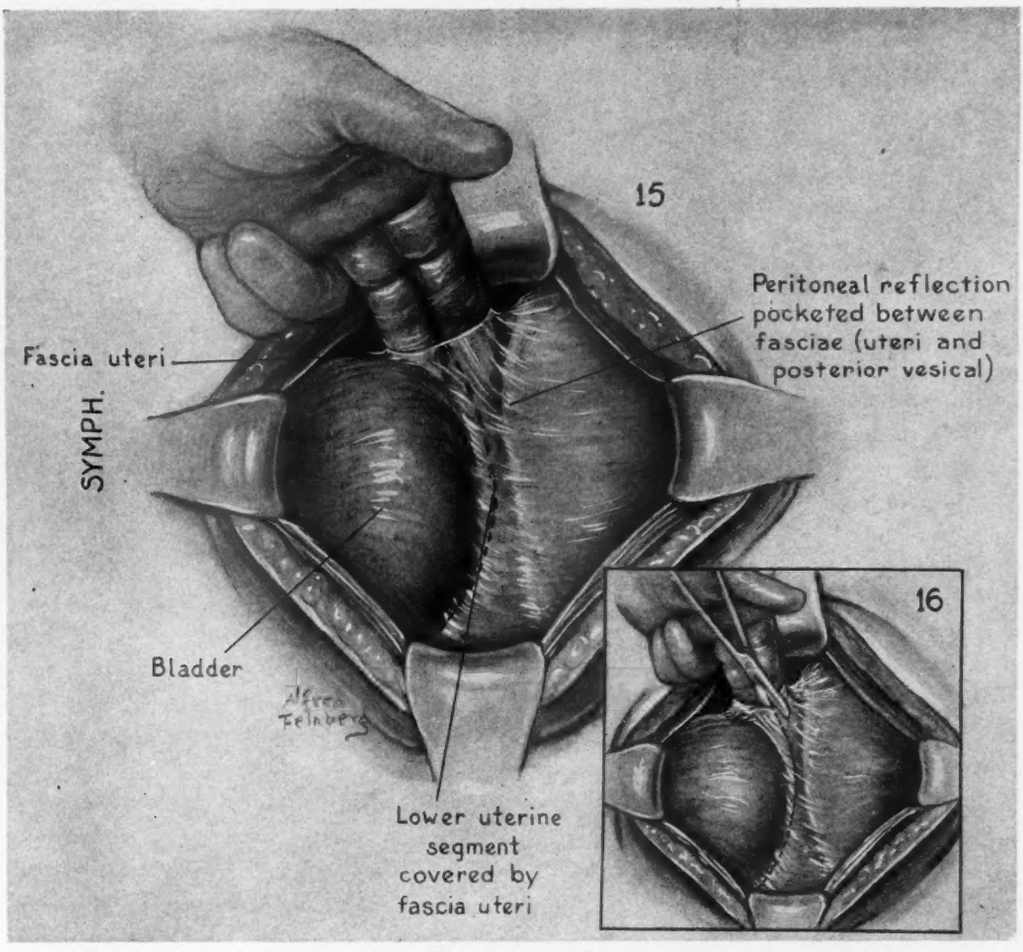
FIG. 14. Relationship of fasciae to displaced bladder and posterior peritoneal fold in mid-line. Cross (*x*) indicates area where fascia uteri is incised to liberate lower segment from fascial covering and permit upward retraction of peritoneal fold.

FIRST MAJOR STEP OF THE EXTRAPERITONEAL CESAREAN

The Liberation of the Anterior Peritoneal Fold from the Upper Bladder Surface and Dome. Visualize and feel the empty "pancake" bladder. It lies underneath the widespread fascia transversalis and is completely enveloped (anteriorly and posteriorly) by the vesical fascia. Finger massaging of the bladder with the fascial coats for a few moments helps to contract the anesthetically relaxed bladder musculature and loosen the viscus from its fascial capsule. The smaller the bladder circumference, the easier the liberation from its lower segmental bed. A firmly contracted bladder helps to eliminate bladder injuries.

With two curved Kelly clamps, grasp the fascia transversalis and the sublying juxtaposed anterior vesical fascia about a good inch below the bladder dome, exactly at mid-point. Between these two clamps, incise all the laminations of the fasciae, except a layer closest to the musculature of

the bladder. Leaving this protective terminal lamination on the bladder permits insinuation of the finger and "decapsulation" company." The anterior vesical fascia swings completely around to cover the posterior surface of the bladder, while the



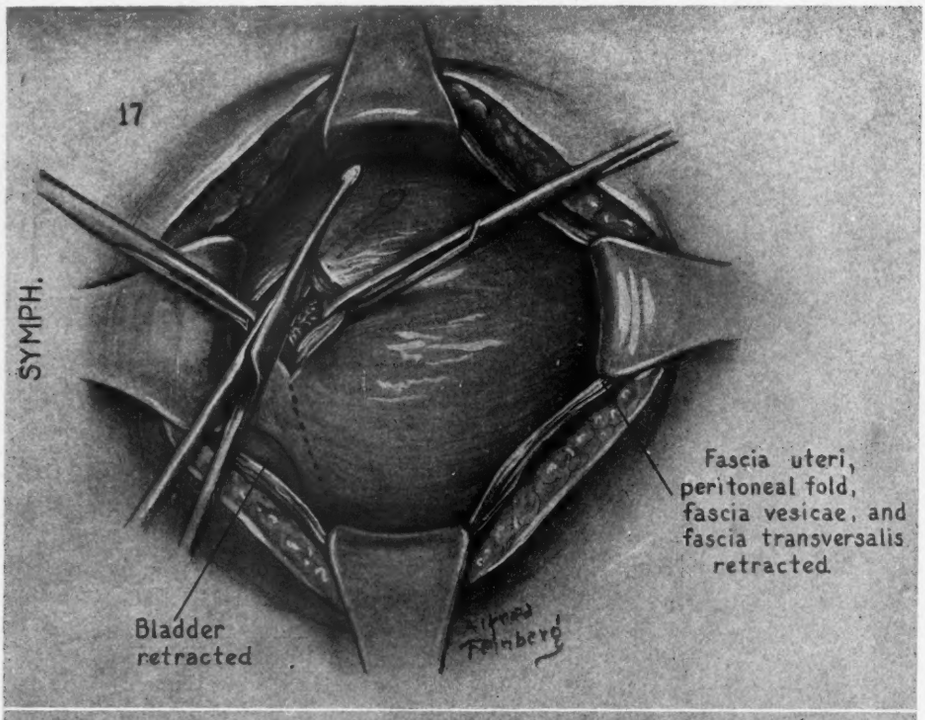
FIGS. 15 AND 16.

FIG. 15. Fingers rest on lower uterine segment and are covered by fascia uteri and posterior vesical fascia. Dotted line indicates line of incision.

FIG. 16. Cutting of fascia uteri below peritoneal fold.

of the bladder dome with greater ease, and minimizes injury to the tortuous vesical blood vessels. Enlarge this incision laterally to permit intrusion of index finger or use a Kelly clamp. Swing the finger (or clamp) in fan fashion from left to right, well beyond the lateral wall of the bladder and well over the dome of the bladder. These liberated fasciae are incised arc-like, curving downward behind Poupart's ligament. This procedure exposes the paravesical fossa. It is to be noted that up to the lateral wall of the bladder, both fasciae (the anterior vesical and the transversalis) are incised; beyond these, the fasciae "part fascia transversalis continues its spread toward the lateral wall of the pelvis and abdomen extraperitoneally. Make certain that the bladder dome is free. The urachus is seldom found troublesome, since it is adherent to the surface of the fascia vesicae at the dome and is, therefore, easily liberated. Pregnancy tends to thin out this structure, but when fibrous and unyielding, it must be cut with care, hugging the bladder fibers. This completes the first major step of the operation—the liberation of the anterior peritoneal fold with its fascial protection from the anterior surface of the bladder and bladder dome.

FIG. 17.



FIGS. 18 AND 19.

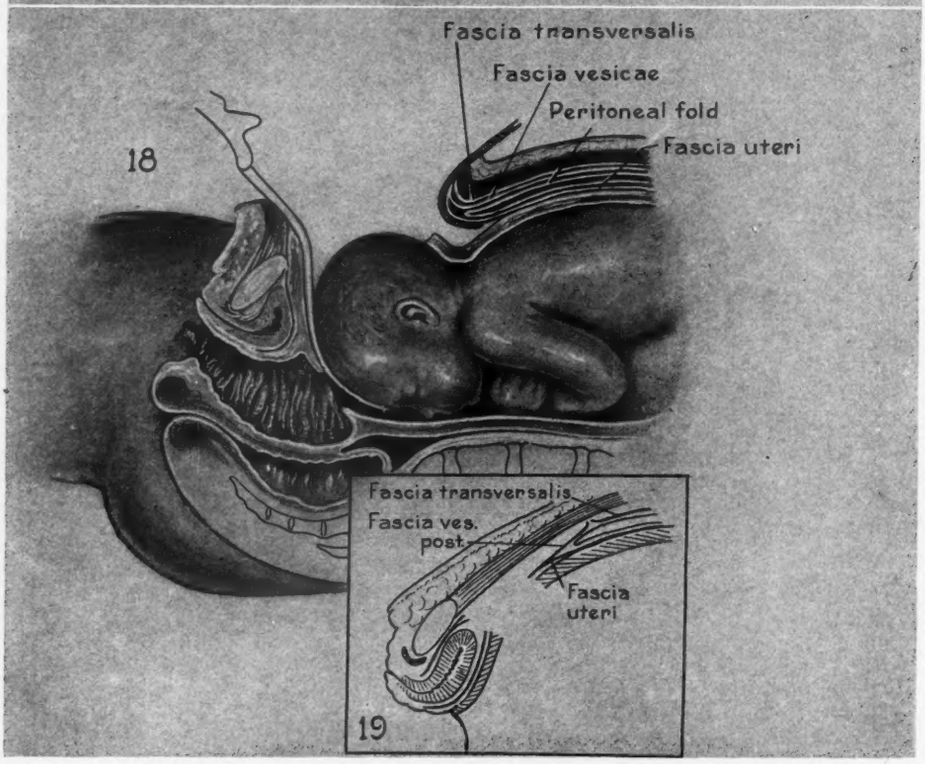


FIG. 17. Exposed lower segment. Bladder lies in the space of Retzius behind retractor hugging symphysis; peritoneum with fascial covering is retracted upward (*cephalad*). Crescentic incision of lower segmental muscular fibers.

FIG. 18. Vertex in anteroposterior position with solid obstetrical blade in place over brow. Delivery facilitated by fundal pressure exerted against obstetrical blade.

FIG. 19. Relationship between cut fascia, bladder and cut surfaces of lower segment. Diagrammatic representation of Figure 18.

SECOND MAJOR STEP OF THE OPERATION

The Liberation of the Posterior Peritoneal Fold from the Posterior Surface of the Bladder and Lower Uterine Segment. Expose the right paravesical fossa by careful and vigorous retraction. By blunt dissection with a curved Kelly clamp, fray the padding fatty tissue. The lateral wall of the bladder and the outermost portion of the posterior peritoneal fold and the fascia uteri come into view. The peritoneal fold appears as a grayish-white transparent apron resembling a flattened empty hernial sac. Anatomically, in this area lateral to the bladder wall, the peritoneal fold lies flattened out on the fascia uteri juxtaposed to the lower segment. Directly behind the flattened bladder, the peritoneal fold is the true vesico-uterine fold of the non-pregnant state, while lateral to the bladder, the peritoneal fold corresponds to the layers of peritoneum as it "hammocks" from the round ligament to the anterior abdominal wall. Continuing the operation in the right paravesical fossa, identify the edge of the posterior peritoneal fold, displace the bladder laterally and downward toward the symphysis. Incise the transparent fascia uteri just below the edge of the peritoneal fold sufficiently to permit insertion of index and middle finger. By insinuating fingers from right to left, the bladder is separated and elevated from its lower segmental bed. This maneuver brings into clear view the dome of the bladder, the posterior vesical fascia, the fascia uteri (the two as one structure), and the curved edge of the posterior peritoneal fold. With a scissors, cut the intervening tissue (fascia vesica posterior and fascia uteri) between dome of bladder and posterior peritoneal fold from the right to the left side of the bladder. No tissue should be incised until the edge of the peritoneal fold is clearly visible. This completes the second major step of the operation—the liberation and upward displacement of the posterior peritoneal fold and downward displacement of the bladder, exposing the entire lower segment.

Feel the presenting part retrosymphyseally, locate mid-point of the lower segment and make a one-inch transverse incision. Hold the knife perpendicular to musculature to avoid bevelling, which increases bleeding in the now thinned-out segment. Avoid knife injury to presenting fetal part. When the vertex is visible, grasp upper and lower cut margins with Allis clamps and insert a suture in the clamped tissue.These sutures serve as guides and for traction in the repair of the lower segment. Lengthen this incision on both sides of mid-point for about 2½ to 3 inches in crescent shape. At the extreme ends of the incision, the musculature of the lower segment thickens moderately. Again insert sutures at both ends of incision to act as guides in the repair and for hemostasis.

When the lower segment incision is completed, remove all retractors. Do not disturb presenting vertex, irrespective of position. Insert solid obstetric blade or vectis behind the occiput, the jaw or chin, depending on position. Let assistant (usually anesthetist) exert vigorous pressure fundally and laterally toward symphysis (Marr prefers version in all cases). If vertex is large and incision small, rotate vertex to anteroposterior position and deliver by extension. Immediate delivery of placenta is preceded by the use of pituitrin and ergotrate.

Locate guide sutures and by traction bring the incisional margins into view. Pack fundus and lower segment area with iodoform gauze. Repair with two layers of chromic No. 0 sutures. Elevate bladder to original position, and with several interrupted sutures, reunite the transversalis fascia. Sprinkle sulfanilamide powder over operative field and insert rubber tissue drain.

CONCLUSION

A series of 175 cases of extraperitoneal cesareans is presented with a brief analysis of the mortality, morbidity and complications. A technic is described and the steps of the procedure portrayed which facilitate and simplify the operation.

SADDLE BLOCK ANESTHESIA*

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NEW ORLEANS, LOUISIANA

AND

LIEUT. D. ROMAN-VEGA

MEDICAL CORPS, ARMY OF THE UNITED STATES

SADDLE block is a term used to designate a form of low spinal anesthesia. The term, low spinal anesthesia, usually implies that the areas supplied by the lumbar and sacral spinal roots are anesthetized. In saddle block, however, the lowermost sacral spinal segments are involved and anesthesia is confined exclusively to the saddle area. Saddle block is useful for urological, gynecological, orthopedic and obstetrical surgery.

This type of anesthesia has been described before and is by no means new.[1] However, previous reports are not sufficiently detailed, and do not describe the method of obtaining the selectivity and controllability the writers have developed. One difficulty usually encountered in the technic, as ordinarily described, is the tendency of anesthesia to spread and involve more than the saddle area during the induction period. In the writers' technic, spreading is eliminated almost entirely. Anesthesia confined exclusively to the perineal area without involvement of the legs or thighs is consistently obtained. (Fig. 1A.) By variation of dosage, timing and other technical factors, sensory anesthesia in the legs and thighs without loss of motor activity in the legs may be obtained. (Fig. 1B.) The procedure may be modified further to yield low spinal anesthesia in the ordinary sense of the term. (Fig. 1C.) The controllability in this case surpasses that allowed by low spinal anesthesia induced in the usual manner.

Previous reports have been limited to the use of procaine. The writers have extended the use of the block to other local anesthetic drugs. Pontocaine, nupercaine and other drugs capable of longer action than procaine have been employed.

MATERIALS

In performing the block, the standard set usually employed for spinal anesthesia is satisfactory. The assembly included a 20 gauge short beveled spinal needle, a 5 cc. syringe equipped with a lock which fits the spinal needle, a 26 gauge needle for the intradermal wheal and a 2 cc. syringe which fits the wheal needle. Procaine crystals, 2 cc. of 10 per cent glucose prepared in physiological saline or distilled water and 1 per cent procaine for the intradermal wheal are also necessary items.

TECHNIC

The patient is prepared in the usual manner. A hypodermic of morphine gr. $\frac{1}{4}$ to $\frac{1}{6}$ and scopolamine gr. $\frac{1}{100}$ to $\frac{1}{150}$ is administered one hour before induction of anesthesia. Omission of sedatives during spinal anesthesia, particularly in apprehensive patients, may contribute to failure. On the other hand, oversedation often leads to a lack of cooperation by the patient while the block is being performed. A sedative dose of a short-acting bar-

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biturate, such as pentobarbital, may be given orally along with the hypodermic, but is not necessary.

to perform the lumbar puncture. The best arrangement is to have the patient seated in the center of the operating table

TABLE I

VARIATIONS IN DOSAGE, VOLUME OF SOLUTION AND TIMING NECESSARY TO OBTAIN SADDLE OR LOW SPINAL ANESTHESIA WITH THE CURRENTLY EMPLOYED ANESTHETIC DRUGS

Drug	Preparation	Anesthesia in Saddle Area only (Fig. 1A)				Saddle Anesthesia Sensory of Extremities (Fig. 1B)				Motor and Sensory below L I (Fig. 1C)			
		Dose Mg.	Time Patient Sits Upright (sec.)	Duration of Anes. (hr.)	Glucose Solution (cc.)	Dose Mg.	Time Patient Sits Upright (sec.)	Duration of Anes. (hr.)	Glucose Solution	Dose Mg.	Time Patient Remains Upright (sec.)	Duration of Anes. (hr.)	Glucose Solution (cc.)
Procaine...	Crystals	50–75	35–40	1¼–1½	1	75–100	15.20	1¼–1½	1.5	100–125	0–5	¾–1	2.0
Metycaine	10% solution	50–75	35–40	1½–1¾	1	50–75	15–20	1¼–1½	1.5	75–100	0–5	1 – 1¼	2.0
Intracaine	Crystals	20–25	35–40	1¼–1½	1	25–30	15–20	1¼–1½	1.5	30–35	0–5	1 – 1¼	2.0
Monocaine	Crystals	35–50	35–40	1¼–2	1	50–75	20	1½–1¾	1.5	75	0–5	1¼–1½	2.0
Pontocaine	Crystals or powder	5	35–40	2 – 2½	1	5–8	20	2 – 2½	1.5	8–10	0–5	2 – 2½	2.0
Nupercaine	0.5% solution	2½	40	3½–4	1	2½–5	20	3½–4	1.5	5	0–5	3 – 3½	2.0

A solution of local anesthetic drug and glucose is prepared for intrathecal injection. If procaine hydrochloride is employed, the crystals are dissolved in the necessary amount of glucose solution. (Table 1.) The mixture is drawn into the syringe and set aside until the lumbar puncture is performed. It is desirable to prepare the solution in advance of the lumbar puncture. The possibility of failure due to dislodgment of the needle by sudden movements of the patient while the solution is being prepared is thus averted. The time-honored custom of withdrawing spinal fluid and mixing it with the anesthetic drug is dispensed with in this technic. The upright sitting position must be used with legs dangling over one side and arms folded across the chest. The patient's shoulders are supported by an attendant who faces him as he leans slightly forward. The fourth interspace (between lumbar 3 and lumbar 4) is preferred for the puncture but the third may be used if difficulty is encountered. The syringe containing the solution is attached to the needle and aspiration is attempted to determine whether or not spinal fluid flows freely. Not more than 1/10 cc. of fluid should be aspirated into the syringe during this maneuver, otherwise the solution becomes diluted. Should the spinal fluid not flow freely, the syringe should be disconnected, the stylet replaced and the needle readjusted

until a satisfactory puncture and flow are obtained. The majority of failures in spinal anesthesia are due to unsatisfactory lumbar punctures.

than spinal fluid. The solution, therefore, gravitates downward, aided of course, by the upright position of the patient. If the patient is placed in the recumbent position

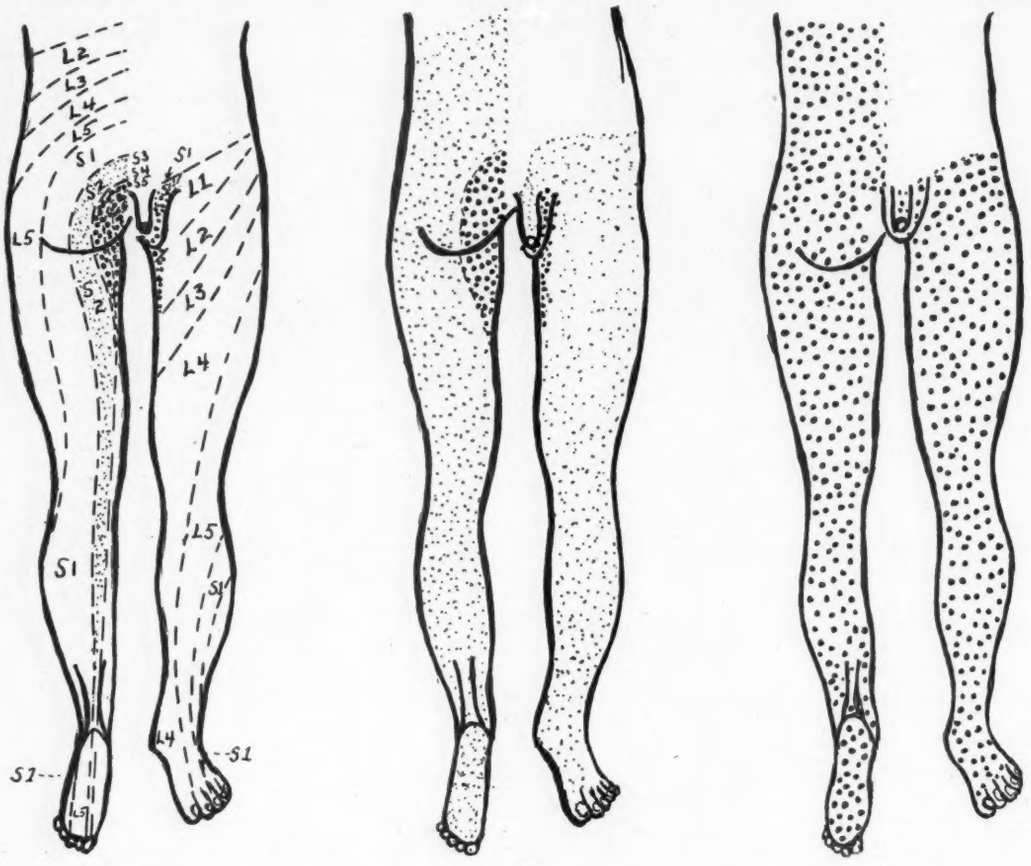

FIG. 1. Distribution of anesthesia which may be obtained by varying the technic for saddle block. Heavily dotted areas indicate motor paralysis and sensory anesthesia. Lightly dotted areas indicate sensory anesthesia without motor paralysis.

The solution is injected as rapidly as it will flow when gentle pressure is applied to the plunger of the syringe. The needle must be held firmly with the left hand during the injection. This detail is of utmost importance because failure to obtain anesthesia after an apparently satisfactory lumbar puncture is due to dislodgment of the needle during injection of the solution. After the injection is completed and the needle is withdrawn, the patient must remain in the upright sitting position for a period of time to be determined by the extent of anesthesia desired. The glucose, as demonstrated by Sise,[2] causes the procaine solution to be hyperbaric or heavier immediately after completion of the injection, the solution mixes with spinal fluid in the lowermost portion of the spinal canal and becomes partly diluted. The procaine thus is distributed along the lumbar and sacral segments. If the patient sits upright for a period of forty or fifty seconds, the drug becomes concentrated in the conus and undergoes little or no dilution with spinal fluid. Anesthesia in this case is confined to the saddle area.

It is well recognized that sensory fibers of a nerve are affected more readily than motor fibers when exposed under similar circumstances to a given concentration of a local anesthetic drug. It is possible, if a

local anesthetic drug is sufficiently diluted in the subarachnoid space, to obtain sensory anesthesia with little or no motor paralysis. In this technic, selectivity of distribution and degree of intensity are obtained by varying the dilution at the different spinal segments. (Fig. 2.) Proper dilution is obtained by varying the amount of drug, volume of solution and the time which the patient remains upright. Anesthesia confined entirely to the perineal area may be secured by using 50 to 75 mg. procaine and by allowing the patient to remain upright for thirty to forty seconds. Occasionally there may be some hypalgesia, but usually no anesthesia at all is obtained over the legs and thighs. This extent of anesthesia is satisfactory for rectal, urological, gynecological and other perineal operations. Excellent relaxation of the pelvic floor and sphincters is obtained. This distribution of anesthesia, however, is not satisfactory for operations upon the fundus of the uterus, such as one

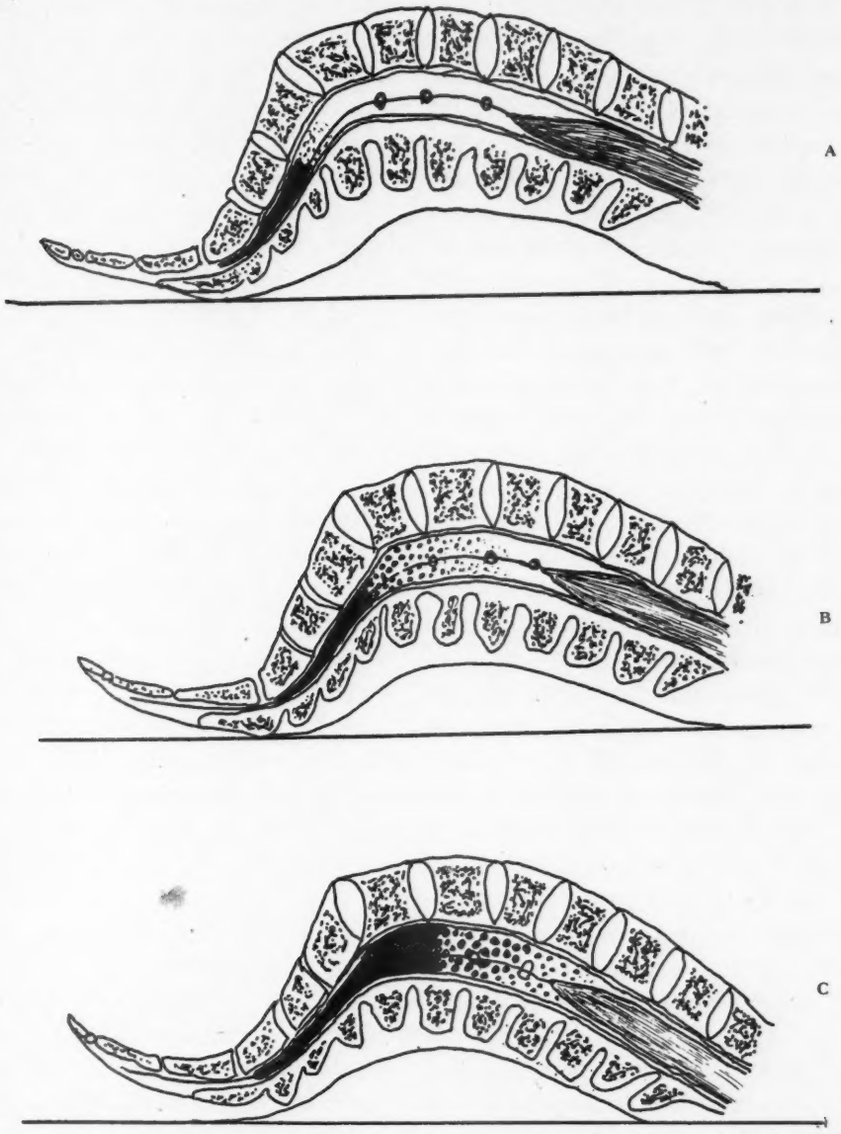

FIG. 2. Variations in concentration of the drug in the conus of the dural sac and their relationships to the extent of anesthesia obtained. Black area indicates concentration sufficient to affect motor as well as sensory fibers. Dotted areas indicate dilution which affects chiefly sensory fibers. In A, the concentration corresponds to distribution of anesthesia shown in A of Figure 1; B corresponds to B of Figure 1 and C to C of Figure 1.

requires for vaginal hysterectomy, or upon the bladder. These parts receive innervations from the lumbar nerves which, in this case, are not affected by the drug. Analgesia, with no loss of motor activity in the legs, results when 75 to 100 mg. procaine are employed. The patient is allowed to remain upright a shorter interval, usually ten to fifteen seconds. The perineal area and genitalia are completely anesthetized and the muscles of the pelvic floor are relaxed. This distribution of anesthesia is desirable when the lithotomy position is contemplated. In long operations, the awkward position causes discomfort if the legs and thighs are not anesthetized. Motor and sensory anesthesia below the 1st lumbar segment may be obtained by using 100 to 120 mg. procaine and placing the patient in the recumbent position immediately or within several seconds after completion of the injection. Orthopedic and other operations about the extremities which require muscle relaxation and this distribution of anesthesia may thus be performed.

As soon as the patient is placed in the recumbent position, the head is supported by a pillow and the table is tilted to the reverse Trendelenburg position at an angle of approximately 5 degrees. A caudad, rather than cephalad migration of the solution, is thereby assured. "Creeping" or spreading of anesthesia beyond the desired segment is thus averted. The patient must remain in the inclined position for a minimum of five minutes before being shifted to the Trendelenburg, lateral, Sims or other position necessary to complete the operation. The glucose becomes diluted with spinal fluid after this period of time and no longer causes a cephalad advancement of the drug in the spinal canal. The onset of anesthesia when glucose is used with procaine requires a somewhat longer period of time than when procaine alone is injected. In many instances, five minutes or more may be necessary for motor paralysis and sensory anesthesia. Hypalgesia, which precedes anesthesia, ensues almost immediately. The duration of anesthesia varies from one to one and one-quarter hours. A sensory examination should be performed to determine the distribution of anesthesia before the operation is allowed to proceed. The testing is done by light pin scratches which the patient identifies as different degrees of sharpness at first. Later, the feeling of numbness becomes apparent. Once anesthesia is established at the desired segment, there is little tendency for it to "creep."

Metycaine, nupercaine, pontocaine, monocaine, intracaine and other drugs may be substituted for procaine with minor variations in technic. Dose, time, volume of solution, duration of anesthesia and other necessary details for using each drug are listed in Table 1. The technic is fundamentally the same regardless of the drug employed. The onset of action with each of these drugs, as in the case of procaine, is longer when glucose is used than when the solutions are prepared with water or spinal fluid. Certain anesthetic drugs, notably metycaine, nupercaine, and pontocaine are dispensed in sterile solutions in sealed ampules by the manufacturer because the crystals dissolve slowly or because they require buffers to maintain stability or prevent precipitation. The solution which provides the smallest bulk is preferred in this technic because dilution of the glucose is undesirable. Besides, the success of the technic depends upon the use of a small volume of solution.

Although the dose employed depends principally upon the extent of anesthesia desired, the age of the patient frequently is an additional consideration. Subjects in the upper age groups should receive the lower limits of the tabulated dose range; young vigorous subjects, the upper limit. Body weight, length of spinal cord and similar factors are not necessary in estimation of dosage unless extremes of height and weight are encountered, in which case the upper limits are used for tall subjects and the lower limit for short.

RESULTS

In 500 surgical procedures involving the perineum, rectum, genitalia and lower extremities, saddle block was induced in 79 per cent and ordinary low spinal in 21 per cent of the cases. Patients varied from fifteen to eighty years of age. Procaine was employed in 55 per cent, nupercaine in 26 per cent, pontocaine in 11 per cent, monocaine in 3 per cent, metycaine in 3 per cent, and intracaine in 2 per cent of the cases. Anesthesia in the majority of the blocks was confined to the perineal area. In seven subjects in whom no satisfactory anesthesia was obtained, the procedure was repeated after ten minutes. Satisfactory anesthesia was obtained after the second attempt. Presumably the failures were due to unsatisfactory lumbar puncture.

No unusual postoperative complications ascribable to the anesthetic were encountered in this series. Nausea, and vomiting appeared in approximately 2 per cent of the cases. Inhalation of oxygen offered relief. Post-lumbar puncture headache was noted on two occasions. The possibility of this annoying and unavoidable complication may be considered an objection to the block. Neurological complications such as palsies, rectal incontinence, paresis of the extremities, which occasionally follow spinal anesthesia, did not appear in any instance in any patient in this series during the period of hospitalization.

COMMENTS

Spinal anesthesia causes a number of physiological disturbances, the severity of which is usually proportional to the distribution and intensity of anesthesia. These physiological disturbances and their attendant side affects are minimal in saddle block. The most common, serious and vexing complication in spinal anesthesia is hypotension. The mechanism causing hypotension, even though it has been the subject of considerable study, is not clear. The circulatory depression occurs somewhere in the periphery, probably in the veins, venules and capillaries. The relaxation of the muscles, the decrease in intra-abdominal pressure, the reduction in the intrathoracic negative pressure which follow the diminution of ventilation from intercostal paralysis, all cause a decrease in the venous return to the heart which in turn results in a decrease in cardiac output. The relaxation of the spleen and dilatation of the vessels in the skin from sympathetic paralysis contribute further to the circulatory depression by causing stagnation of blood in the arterioles, venules and capillaries. The greater the number of dermatones involved and the greater the degree of motor paralysis, the more frequent and severe is the hypotension which ensues. Saddle block offers a distinct advantage in this respect because only the area necessary to complete the operation is anesthetized. The circulatory depression, therefore, should be minimal, or entirely absent if only the sacral spinal nerves are involved. It is poor practice to anesthetize more of the body area or to induce anesthesia of greater intensity than is necessary to complete the operation. This, however, is a frequent error committed by individuals not familiar with the technic of spinal anesthesia.

Approximately 10 per cent of the subjects in this series developed some degree of circulatory depression. In each instance, it was successfully overcome by parenteral administration of ephedrine or neosynephrine. The preoperative administration of vasopressor drugs as a prophylactic measure is unnecessary. In fact, it is undesirable as it often causes an elevation of blood pressure above normal. The drug should be held in readiness and given intravenously if indicated. Hypotension did not appear in any subject in whom anesthesia was confined entirely to the perineal area. In the majority of instances, it was observed when anesthesia extended to the first lumbar segment. The wisdom of using spinal anesthesia in the presence of cardiovascular disease, hypertension, lowered vital capacity, anemia, and other severe

systemic diseases is questionable. The controllability and selectivity which saddle block affords do, however, allow the use of low spinal anesthesia with a greater degree of safety in this particular group of subjects. As is the case with spinal anesthesia induced in the ordinary manner, saddle block should be avoided following hemorrhage, in shock, when dehydration or severe anemia is present, or in otherwise acutely ill or extremely poor risk patients.

Saddle block may be employed instead of caudal, pudendal, tibial and other nerve blocks for anesthesia of the perineum and extremities. The simplicity of induction, the controllability and assurance of success, once a satisfactory lumbar puncture has been obtained, eliminate the uncertainty of obtaining anesthesia and hazards of toxic reactions of local anesthetic drugs which are possible with caudal block and other nerve blocks. Prolonged anesthesia may be secured by selecting the drug which fulfills the needs for the contemplated surgical procedure.

SUMMARY

Saddle block is a form of low spinal anesthesia. A technic has been described which is controllable and yields anesthesia confined entirely to the saddle area. With slight modifications of technic, low spinal anesthesia in the usual sense of the term, may be obtained. Slight variations in technic allow the use of a variety of drugs. Prolonged anesthesia may be secured by the use of long acting drugs, such as pontocaine or nupercaine.

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CHRONIC LUMBAR BACKACHE

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WHEN man assumed the upright posture he not only set himself apart from the animal kingdom, but he also set the stage for a series of disorders of the low back which have plagued him since. Probably in the whole field of medicine there is nothing that so challenges the ability of the practitioner, not only from the standpoint of diagnosis, but also therapeutically. No age group, except possibly the very young, can be said to be exempt, and the greatest incidence occurs in the most physically active part of life.

It is, therefore, important for anyone who has the responsibility of observing and treating these patients to recognize and differentiate the various pathological factors involved. Proper treatment may then be instituted early. In this way long drawn out disability may be avoided in many cases. However, when one considers the low back from an anatomical standpoint, one is impressed with the fact that there are not more people troubled with disability in this area.

I do not intend in this paper to concern myself with such entities as protruded intervertebral disc, neoplasms, infections, arthritis, etc., except to recognize that they do exist. I am more concerned with low back conditions which remain after the above have been excluded and which may be even more troublesome to treat.

The lumbosacral area is subject to a great variety of anomalous conditions, and it is certainly true that these may produce a weak back; however, from an *x*-ray standpoint there are other cases in which no distinct deviation from the normal can be found. In these a careful physical examination will often reveal important findings which will clarify the condition, and give us a firmer footing on which to base our therapy.

COMPARATIVE ANATOMY

In studying the low back it is well to pause for a moment and consider our inheritance, such as it is, from our primate ancestors. For an immediate example of a spinal column of primate type we may observe that of the newborn infant, in which the column at birth is practically straight. The hips are flexed and attempts to extend them meet with considerable resistance. The lumbar region of the human spine measures 27 per cent of the presacral spine at birth. This is the same as the adult chimpanzee. Elongation takes place as the child grows and in the human adult the lumbar spine becomes 32 per cent of the total presacral length.[1] As the child begins to extend the legs in kicking a gradual curve appears in the lumbar spine, which at five months becomes quite pronounced. Between thirteen months and three years the lumbar and thoracic curves are quite well established, due in part most likely to assumption of the upright posture.[2] In this short period of time the child passes through stages the counterpart of which man, in his greater development, has taken thousands of years to progress through.

To accomplish the upright posture certain changes or modifications of the primate skeleton have occurred, particularly in the pelvis and lumbosacrum. The ilia have enlarged, widened and spread out in the form of a basin offering easy support for the abdominal viscera.[3] The lumbar spine was shortened by sacralization of the seventh, then the

sixth lumbar vertebrae, and strengthened to become a flexible lever on which the whole weight of the upper part of the body is poised. Due to the disappearance of the tail, the dorsal surface of the sacrum became free and tipped backward for the encroachment of the erector spinae muscles. However, Sir Arthur Keith states, that not a single new muscle has been added to accomplish the orthograde posture. Evolution proceeded by combining a series of independent fasciculi acting individually to form a single muscle which acts on a region as in man rather than on a single vertebrae as in the gibbon. The brunt of adaptational changes has fallen on spinal musculature of the lumbar region.[4] This may to the discerning observer offer a clue to our present difficulties.

In order to accommodate for the upright posture other changes must of necessity have taken place. The lower limbs must have early assumed the human form, and as headward sacralization occurred the lumbar and sacral plexuses also moved in this direction. The thorax was transformed in shape, not for respiratory purposes but for postural purposes, the dorsal musculature of which became better developed to aid as spinal balancers.[5] At the upper end of the spinal column, the neck became more apparent and with the development of the cervical curve man lost his crouching posture and became a being unto himself, the only living creature able to walk erect.

Thus we can see that we are concerning ourselves with a region of the body which not only has been subjected to a great deal of change during the evolutionary process, but is not yet in equilibrium. There is probably no other part of the skeleton so subject to anomalies as is the lumbosacral area. It also has assumed the burden of upright posture without additional musculature; that present was merely strengthened.

These then are factors over which we have no control. There are other conditions which we can control and which we shall discuss.

ANATOMY

Most everyone is familiar with the general anatomical details of the lumbosacral region; however, there are certain points worthy of mention. The lumbar spine may be thought of as a complex universal joint operating upon a fixed base, the sacrum and ilia. It is held in position by a system of ligaments and muscles which are quite complex in their arrangement. The most important ligaments and the ones most subject to strain will be those connecting the mobile spine to the relatively fixed sacrum and ilia. In the mobile portion of the spine the ligaments are the supra and interspinous, ligamentum flavum, posterior and anterior longitudinal, intervertebral fibrocartilage, capsular and intertransverse ligaments. At the junction of the spine with the sacrum the intertransverse ligaments are modified to form in one case the fan-shaped lumbosacral ligament attached above at the inferior border of the transverse process of the fifth lumbar spreading out to the alae of the sacrum, and the iliolumbar ligament which extends from the last lumbar transverse process to the inner lip of the iliac crest.[6]

The muscles which include the erector spinae group, psoas major and quadratus lumborum lying posteriorly, may be said to act as elastic ligaments in addition to their function as spinal balancers. Motions at this joint include flexion and extension, lateral bending, slight rotatory and gliding. Rotatory motion is not possible in other segments.

The nerve supply to the lumbosacrum comes from the posterior primary division of the fourth and fifth lumbar nerves. It is well to remember that these nerves are surrounded by a large venous plexus, congestion of which may produce pain. G. A. G. Mitchell, quoting Boniot and Forestier, states that the fourth and fifth lumbar nerves are not protected by

an arachnoid sheath, making them more subject to variations in venous pressure. This observation has not been confirmed.[7]

It is well to mention something of the lumbosacral angle and width of the fifth lumbar intervertebral disc. Von Lachum, some years ago at the New York Orthopedic Hospital and Dispensary, determined the average angle to be 42.5 degrees. He considered the lumbosacral angle to be that angle formed by the plane of the superior surface of the sacrum with the horizontal. This angle should more properly be called the angle of the sacrum rather than the lumbosacral angle. This measurement has wide variations as I have found in a study of a series of *x*-rays in both normal people and those having back pain at the New York Orthopedic Hospital.[8] The width of the fifth lumbar intervertebral disc also varies, but seems to be more frequently narrow in backache cases. Brav, Bruck and Fruchter reported standard disc measurements to be as follows:

Posterior disc,	male	5 mm.
	female	5 mm.
Anterior disc,	male	18 mm.
	female	13 mm.

In a series of seventy backache cases as compared with thirty-five normal controls these men found thin posterior disc in 20.6 per cent of backache cases as compared with 5.3 per cent of controls, and thin anterior disc in 19.1 per cent back cases and in 17.1 per cent of controls.[9] What significance may be attached to a thin disc is difficult to say. When a disc is very thin it is certainly evidence of degeneration if a protruded intervertebral disc has been eliminated.

SYMPTOMS

Symptoms may be divided into acute and chronic. In the acute variety occurring most often following trauma such as a slip or fall or unusual lifting, there may be excrutiating pain in the low back sometimes rather generalized and sometimes quite localized. There is usually considerable muscle spasm in the erector spinae group and often referred pain to the posterior aspect of either or both legs. It is frequently quite difficult to examine these patients properly because of pain. Under these circumstances it is best to put them in bed for a period of twelve to twenty-four hours with analgesics and heat and an attempt then made to examine them when the acute symptoms have subsided. A much more intelligent analysis of the situation can then be made.

The chronic variety with which we are most concerned may have a more or less insidious onset, or may have had its origin rather acutely following some sort of trauma after which chronic symptoms persist. The most constant symptom is dull pain, sometimes sharp, aggravated by movements. It is present more or less constantly in the lumbosacral region although it may radiate out to the loins. It may be referred down the posterior aspect of one or both legs. In some cases it is present in the legs or thighs early, later subsiding, then returning on other occasions. Such referred pain is not necessarily sciatica, a term rather loosely applied to indicate any pain in the posterior portion of the thighs or calves. Some patients localize the pain just at the lumbosacral junction in the midline, whereas others will indicate a wide area on either side as the site of pain.

In some cases the pain is present on arising in the morning, whereas in others it occurs only after being up for several hours. In some cases it may disappear after the patient arises and limbers up. Some individuals will state that rest in bed relieves them, and in private practice we often see patients who have spent weeks in bed only to have their symptoms return when on their feet again. In others going to bed merely adds to their suffering.

Thus it can be seen that there is no constant pattern, but that each individual case must be studied on its own merits, and a conlusion drawn on that basis.

DIAGNOSIS

The effectiveness of therapy rests upon a very careful physical examination, which should include all parts of the body. Ordinary routine laboratory studies such as blood and urine examinations are done and x-ray studies made which will include a lateral, an anteroposterior, and an anterior forty-five degree oblique view through the lumbosacral joint.

The examination of the back can then be carried out as follows: It is upon this examination that the program of therapy described later will stand or fall, for it is here that cases requiring some specific form of therapy must be eliminated.

With the patient standing, observe the general posture and muscle tone. Note any undue prominence of the abdomen. Note the position of the legs, their symmetry, and whether or not they are of equal length. Note the presence or absence of foot deformities, particularly flat feet.

Observe the contour of the spine. Note any deviation from the normal such as scoliosis, increased lordosis, or kyphosis; also any depressions at the lumbosacral joint which might indicate a spondylolisthesis. Note the contour of the erector spinae muscles on either side of the spine.

The patient may then be asked to carry out the usual motions of the spine: flexion, extension, lateral bending and rotation both right and left. Frequently limitation of motion will be noted, in addition to spasm of one or both erector spinae muscles. The patient may complain of pain in the posterior thighs on anterior flexion. Palpate the muscles with the finger tips during the active motions. Palpate the lumbosacral junction, the iliolumbar ligaments, the sacroiliac junction and the sciatic notch for painful points, also the sciatic nerve in the posterior thigh.

The same observations are to be made with the patient seated. This position puts some tension on the hamstring and gluteal fascia and may change the picture somewhat. The pelvis is also flexed when seated, which in some patients creates a more normal alignment of the spine.

With the patient lying down, the following tests are to be carried out beginning with the patient lying face up. As the examiner progresses through the tests the patient simply continues to roll over thus saving time for the examiner.

Gaenslens Test. Drop the right leg over the edge of the table in hyperextension. Acutely flex the opposite leg and apply gentle pressure passively in each direction so as to increase the flexion on the left and the hyperextension on the right. It should be repeated for the opposite side in like manner. This applies a shearing force to the sacroiliac joint and should give discomfort in the presence of pathology.

Goldthwait Test. With the knee in flexion, flex also the hip on the same side. Gradually extend the knee and note the amount of extension possible. Repeat on the opposite side. This test gives us information regarding the presence of hamstring spasm. Normally the knee can be extended to 180 degrees.

Straight Leg Raising. With the knee in extension gradually flex the hip on the same side. Limitation of flexion to more than 100 degrees may indicate tight gluteal or hamstring fascia or hamstring spasm.

Laguerés Test. Flex the right knee and hip, externally rotate and abduct the thigh. This test should elicit spasm and pain in the presence of hip joint disease. The test is repeated for the opposite side.

Ober Test. With the patient now lying on the left side, acutely flex the left hip and knee. Gradually hyperextend the right hip, allowing it to drop into adduction when it has fully extended. Tight tensor fascia will prevent it from adducting under these conditions. It can be repeated for the opposite side when the patient is rolled over in the progress of the tests.

Ely Test. With the patient lying face downward and hips extended, the examiner passively flexes the knees. If the quadriceps

fascia is tight, the buttock will raise on that side.

By listing only these tests I do not mean to imply that they are the only ones in use. There are many others of equal value. The important point is to know certain tests and their value in diagnosis.

With the patient now lying face down it is possible carefully to palpate the spine, the iliolumbar ligaments, the sacroiliac joints and posterior superior spines, the sciatic notch and also to follow the course of the sciatic nerve down the posterior thigh. Very often light pressure applied at the fifth lumbar spine will reveal considerable tenderness in this area.

I wish to make a special point of examining for the presence of fasciitis at this stage of the examination. In association with low back conditions it is most characteristically found in a rather large area extending as low as the sacrum, sometimes as high as the first lumbar vertebrae and out to the loins on either side. When a large fold of skin is grasped between the thumb and finger in a normal person and an attempt made to roll the fold progressively forward there is a feeling of normal tissue tension. The normal skin does not feel thick and boggy, and is not painful as this is done. In the presence of fasciitis the tissue is thick and boggy and there is quite marked pain or tenderness. This is particularly true if the skin is pinched.

Characteristically, there are no reflex changes in the lower extremities in simple unstable fifth lumbar conditions. However, as a patient is seen from time to time the patellar or Achilles reflexes may occasionally be diminished. Unless this reaction occurs consistently it should be of no consequence, particularly if other findings are not indicative of a neurological lesion.

TREATMENT

We have now arrived at the point where we have a patient complaining of constant low backache. The examination revealed tenderness at lumbar five with mild fasciitis present. The posture is fair, but there is a tendency to stand with slightly increased lumbar lordosis and the erector spinae muscles are not too well developed. We have also found, after carrying out the various tests described under examination above, that the gluteal and thigh fascia are tight.

The *x*-ray may be normal or show some mild anomalous change such as spinae bifida occulta, asymmetrical facets at lumbar five or posterior displacement of the fifth lumbar vertebrae on the first sacral. Theodore Willis, however, believes that this anomaly is an optical illusion. We will consider that we are dealing in this case with a so-called unstable fifth lumbar vertebrae.[10]

We will place this patient on a program of therapy, that for simplicity in discussion will be the same for every case of this type, but which can be varied to suit individual requirements. The treatment is outlined as follows—

1. General therapy
   (a) general toning up
   (b) lumbar belt
   (c) corrective shoes
   (d) see patient frequently
2. Physical therapy
   (a) radiant heat
   (b) massage
   (c) exercises
3. Home therapy
   (a) bed boards and mattress
   (b) radiant heat or other forms
   (c) exercises

General Therapy. The weak back must not be considered a simple local problem, for many times there are general conditions which may prolong the disability. The question of adequate sleep in the prevention of fatigue, of the patient's working and living environment and of his general health, all must be considered. Some form of mild sedative or analgesic may be needed for a short period. A change of occupation or duty is sometimes also necessary.

In order to reassure the patient and to check on his progress the physician should see him twice weekly for the first two weeks and at least once a week thereafter. In this way changes in the treatment can be made in accordance with the patient's progress.

Often the question of whether or not to order a lumbar belt must be decided. I think that most chronic cases will benefit by the use of a well fitted belt. This should be made just wide enough to be worn between the iliac crests and the trochanters. The use of a keystone shaped pad (Cooke pad), which is laced to the back of the belt so as to fit in the hollow of the lumbosacrum, is advantageous. There are many varieties of patent belts; however, none of them offer any particular advantages over a simple well made belt, built to lace or buckle in the front, and adjustable to allow for changes in girth.

Corrective shoes may be prescribed for patients with flat feet. These may be of the semi-orthopedic type, with an inner heel wedge of $\frac{1}{8}$ to $\frac{3}{16}$ inch and a scaphoid or long arch pad of felt or rubber which may be glued to the inner sole. Particular attention should be paid to the shoes of women complaining of backache because the high heels worn by them contribute to the disorder by throwing the lower extremities and pelvis out of balance.

Physical Therapy. While all elements of the treatment program are important, we will of necessity find ourselves depending most upon the physical therapist. It is, therefore, important that the technician understand thoroughly what is expected of him, and that it is not simply a matter of turning on a light and rubbing a patient's back for a few minutes. It is such half-hearted therapy that produces and prolongs a great deal of low back disability.

Radiant heat for twenty minute periods is probably the best form of heat and can be given very easily. The light should be diffusely focused in its reflector so that there are no hot spots to burn the patient. This should be followed by deep massage for about twenty minutes. In the presence of fasciitis pinch massage to the involved area can be given beginning with short periods of five to ten minutes gradually increasing the time. Such massage is at first quite painful.

The patient is instructed in a routine of graduated exercises and posture improvement which is carried out at home twice daily. It is well to write out instructions, because most patients forget very quickly what they are told. The exercises done at home will be the same as those performed under the direction of the physical therapist. A word of caution in the use of exercises may be mentioned. They should not be done simply to occupy the patient's mind, or simply to give him something to do. We should have a definite end in view, and prescribe our exercises accordingly.

Usually it will be necessary to strengthen both the anterior abdominal and erector spinae groups of muscles, and thus indirectly accomplish pelvic tilting or flexing of the pelvis. Pelvic tilting is necessary to decrease the angle of the sacrum, and to place the sacrum under the lumbar spine, much as a waiter holds a tray over his head with his hand. In this way the spine is better balanced, and the lumbar lordosis is decreased.

We may begin rather gradually by asking the patient to contract the anterior abdominal muscles several times, then repeat the exercise and attempt to tighten the buttocks at the same time. In order to give him some idea of what we mean by decreasing the lumbar curve, he may be asked to stand with his back to a flat wall with heels and head touching the wall. He should then flatten his shoulders and lumbar spine against the wall, and walk away with this posture. It may feel abnormal at first, but as he continues with the program it will gradually feel more natural.

He may then be asked to lie face up on the floor, elevate the arms over the head and take in a deep breath as this is done. Repeat the maneuver several times. The pelvic tilting and the buttock pinching exercises should be repeated on the floor,

because under these conditions the lumbar lordosis is partially obliterated. To these may be added progressively any number of hip flexing, trunk bending, and breathing exercises with or without the use of apparatus such as parallel bars, weights, etc.

Tight fascia will usually be relaxed during a program of this type; however, in some instances more direct therapy may be needed. In the case of tight hamstring and gluteal fascia the patient may lie on a table face up. One or the other leg is then passively flexed at the hip with the knee extended and applying moderate pressure. This maneuver is carried out by the physical therapist several times until it is apparent that the fascia is relaxed. Tight tensor fascia may be relaxed by a simple exercise. The patient stands at right angles to a table, about a foot from the edge. He then adducts the hip nearest the table, keeping his feet in place and supporting himself with his hand on the table. This can be repeated for the opposite side by simply facing about.

Home Therapy. The patient should be instructed to secure a bed board measuring about 3 feet by 5 feet to be inserted between the mattress and the spring of the bed. Two table leaves or boards of similar dimensions will do if nothing else is available. If possible a firm horsehair mattress should also be obtained. I have in a number of cases seen chronic backache disappear as if by magic when a horsehair mattress and boards were substituted for an innerspring mattress.

The exercises which were learned under the guidance of the physical therapist should be continued for twenty-minute periods twice daily, and if possible some form of radiant heat. If this is not available, some other form of heat may be used, such as hot moist packs, hot tub or direct hot shower on the back. An old fashioned electric toaster is a good source of dry heat. Any patient who is overweight or obese should be placed on a strict reducing diet. The importance of removing excess weight cannot be over stressed.

With a course of treatment planned in this manner the patient should very shortly experience some relief, and very soon thereafter more or less complete relief. In some cases, however, active treatment may have to be carried out for three to four months. The patient should expect to continue more or less indefinitely the practice of correct posture, the proper lifting of objects and the exercises. The lumber belt may be discarded after a few months, although many patients will continue to wear it for a certain feeling of security which they get.

CONCLUSIONS

1. Man, as a result of assuming the upright posture, has inherited a potentially weak structure, the lumbosacrum.

2. This area is subject to anomalous changes and is therefore not in equilibrium.

3. This area may be easily overburdened by poor posture, obesity, asthenia, and trauma such as slips or falls resulting in chronic low back disability.

4. Every case should be carefully studied to rule out obvious causes of disability such as protruded intervertebral disc, infections, fracture, arthritis, anomalies, etc.

5. Those cases which remain can be treated with gratifying results by a program such as outlined in this paper.

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CAUSES OF DEATH IN BURNED PATIENTS*

A REPORT OF TWENTY-THREE DEATHS IN 744 BURNED PATIENTS

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THE inspiration to prepare this report is the results obtained in the treatment of 744 consecutive burns with the loss of but twenty-three, 3.1 per cent.

Medical literature shows such diversion of opinion regarding the treatment for burns that the physician who is called upon to treat an occasional burn finds it hard to make a decision as to which treatment to use. Fortunately, small burns heal and the patient recovers irrespective of the treatment used, or as a matter of fact, despite the treatment in many cases. There is no treatment which is ideal, that is, that will in a short period transfer the patient from his serious condition to one of near normalcy. Irrespective of the treatment used, the seriously burned patient has a hard road to travel. Burns covering 10 per cent of the body surface will recover in the vast majority of cases irrespective of what is done for them. Most patients having up to 25 or 30 per cent will recover under difficulties with almost any treatment. When the patient receives a burn of over 30 per cent, it does make a difference what is done. Thirty to 40 per cent is the maximum to recover under many treatments. A recent article in one of our prominent medical journals cited several hundred patients, in which a respectable number up to 30 per cent were saved, a lesser number between 30 and 40 per cent, and of the seventy-two who were burned 40 per cent or more only one recovered. The patient having a serious burn has a better chance of recovering following the use of tannic acid, silver nitrate and drying than from the use of any other treatment which has been brought forward. Three of our patients who had over 80 per cent of their body surfaces burned recovered under the prompt and efficient use of tannic acid and silver nitrate followed by drying. One had over 80 per cent of her skin burned and 60 per cent was still unhealed at the time she was first seen some thirty days after the accident. She was temporarily grafted from her mother and later auto-grafted. The second, a 86 per cent burn was seen six weeks after being burned and skin grafts were placed on the unhealed areas. The third patient received a burn covering over 90 per cent of his body surface and was seen on the twelfth day. His feet, one leg slightly above the ankle, the top of his head, the apices of both axillae and three or four other small scattered areas were not burned. Otherwise his skin was completely burned. He also was temporarily grafted from his father.

These patients were saved because they were under treatment promptly with a treatment that stopped the fluid loss and the fluid shift at once. Experimental work[1] on dogs, who do not weep when burned as humans do, show some interesting facts. It was determined that of the total fluid shift or edema following a burn or injury to one side of the body, 40 per cent occurs during the first hour. It is, therefore, reasonable to assume that a treatment which is effective in stopping this fluid shift at once should save more patients by lessening the time over which the dehydration continues than one which

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acts slower. Furthermore, the fluid loss in humans, also, is promptly stopped. We know of no experimental evidence as to just how much of this seepage takes place during the first hour but it undoubtedly would be as great or greater than the 40 per cent shown for the fluid shift.

The burned patient who dies early does so because of dehydration and shock due to the loss of circulating body fluids. Insufficient fluids are left in the circulating blood stream to carry on the bodily functions. The sooner this loss is stopped the less fluid is lost; and if fluids are administered promptly and in sufficient amounts, the patient has a better chance of recovery than if either is delayed.

The application of tannic acid followed by silver nitrate is not the entire treatment. It is just as important to dry the surface at once and to keep it dry throughout treatment. The treatment then is most efficient. Unhealed areas are treated with oxyquinoline sulphate scarlet R gauze.*[2] This gives the quickest and smoothest healing of anything we have ever used.

Statements in the literature show that when tannic acid is injected into muscle or otherwise under the skin, central lobe damage of the liver results. The author does not question this fact. However, the conditions under this treatment are entirely different. Tannic acid solution is applied and immediately, within a very few minutes, the silver nitrate solution is applied. There is a chemical combination between the tannic acid and the fluids on the surface and a second chemical combination between the silver nitrate and the first combination. At once, the tannic acid and the silver nitrate and the surface fluids are fixed in an insoluble, irreversible, undigestible matrix, and nothing is absorbed. As a matter of fact, the surface is immediately turned into one that is inocuous, protective and one that prevents the loss of further fluids and the further shift of fluids. The movement of the fluids is the result of the presence of irritants. These irritants have been removed, rendered inactive at once by the treatment.

Medical history of the late 1890's tells that after reports of the usefulness of diphtheria antitoxin were about to be accepted a hue and cry was raised against it because some of the patients after recovery were found to have heart lesions. At once antidiphtheretic serum was blamed. However, cooler heads pointed out that quite the contrary occurred, that not only did the serum save diphtheria patients but that it saved them despite the heart injury. When this was realized antidiphtheretic antitoxin promptly was restored to good favor.

The tannic acid and silver nitrate treatment[3,4,5] requires drying completely, promptly and continuously. When this is carried out, as it can be, there is no infection under the coagulum and there is, therefore, no secondary period of infection with its rise in temperature, high white blood counts and all the things that go with them. However, when drying has not been completely carried out there is, of course, some moisture beneath and further systemic reaction, however to a much less extent than if tannic acid and silver nitrate had not been attempted.

As an indication that the absorption of the surface substances are promptly stopped and further prevented is the fact that under this treatment urinary suppression and albuminuria have never occurred in our experiences provided that grease or oil has not been applied either as a treatment or as the burning agent.

Treatment of a severe burn calls for all the medical knowledge that the surgeon has.

The following is a brief consideration of the twenty-three patients who did not recover out of a total of 744. Not included in this number are two. One was seen on the

* Oxyquinoline sulphate scarlet R gauze is made by immersing wide mesh (28 by 24) rolled bandages in the following ointment heated on a water bath.

Rx.	Oxyquinoline sulphate	gr 10
	Trichlorbutanol (chloretone)	gr 40
	Scarlet R (National Formulary)	gr 96
	Oleum Ricini (castor oil)	ounces 4

third day of his burn in consultation only. This was a man eighty-seven years of age who received a 15 per cent burn of his lower back, the fall into the hot water having been caused probably by an apoplectic stroke. He died the next day.

The second was a girl of twelve years who was likewise seen some distance from Portland and who received a 60 to 70 per cent burn which was treated with tannic acid and silver nitrate solutions without any attempt having been made to dry the surface. Of course there was much infection. When seen in consultation the application of a heated tent for drying was urged but this was never even attempted. The child was sent in in a septic condition at the end of the third week and died within twenty-four hours. She did not receive the tannic acid and silver nitrate and drying treatment.

CASE REPORTS

Case I. E. D. Y., age two and one-half years, received several small burns of the legs from a stovelid which was placed in the bed when under treatment for whooping cough meningitis from which she suffered. She was seen a few hours after the burn which covered considerably less than 1 per cent of the body surface, of second degree. She died on the third day after the burn of her meningitis as was proven by autopsy. Surely this was not a burn death.

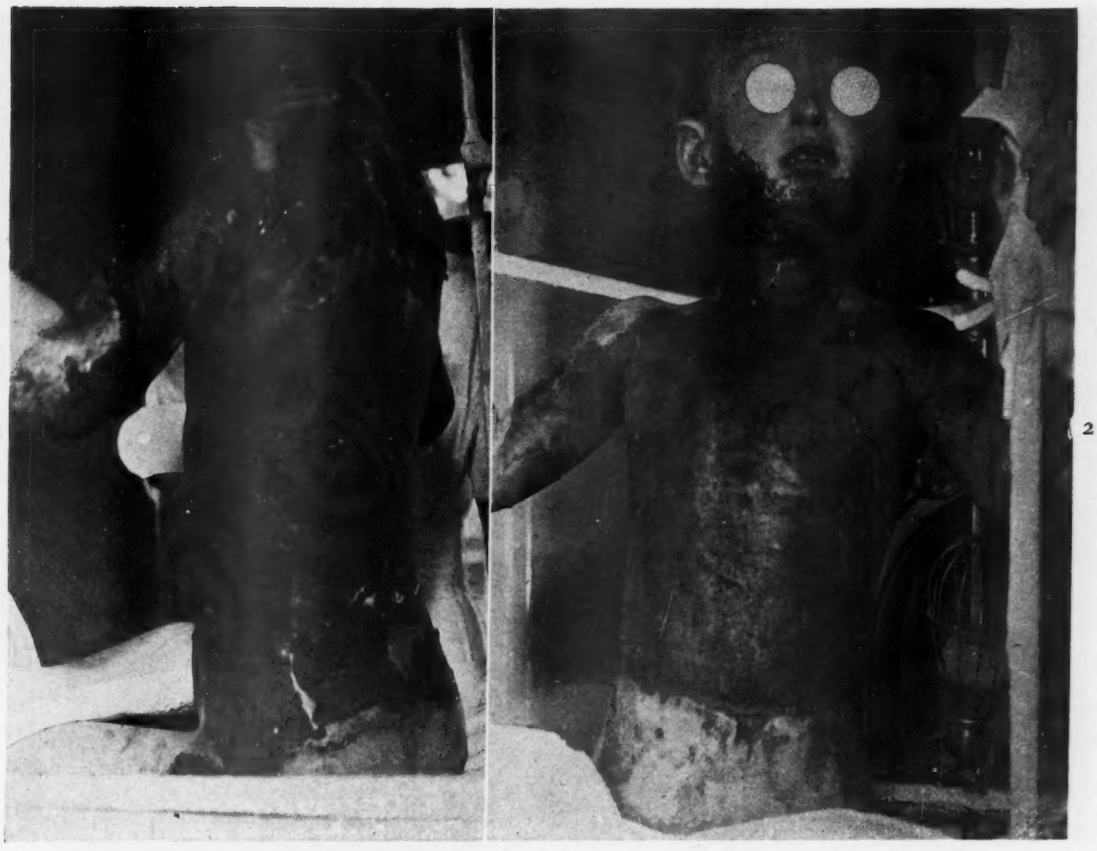
Case II. J. B., male, forty years, received a 35 per cent burn from a tar explosion. He was under satisfactory treatment by tannic acid and silver nitrate and drying within two hours and was seen the next day. He was in a tent and the surface was dry. Upon arriving at the hospital the patient called his attorney, made his will, and stated that he wanted to die. He fought off everything that was done for him and refused to take fluid. He turned and twisted so that the needle in his vein would not stay in place. He died on the third day.

Case III. F. H., male, age two years, received a second and third degree fire burn of about 4 per cent of his body surface and was seen two hours later. Grease had been applied. This was removed with ether. The entire area was healed by the eighteenth day except a spot about ½ inch in diameter which was very superficial. On this day, for some slight indisposition, the mother gave this two-year old child a teaspoonful of bicarbonate of soda and repeated like doses until the child had received eight teaspoonsfuls. When the child had a convulsion a pediatrician was called and the child was rushed to the hospital. He died of an alkalosis on the twenty-first day after the burn.

Case IV. E. B., male, age eighty-four years, received a small burn of the elbow and of the chest wall neither being more than two by three inches, of second degree, when he attempted to make himself a hot water bottle after suffering a chill at night. Following the burn he went to the hospital where it was determined he had pneumonia from which he died on the sixteenth day.

Case V. J. C., male, age fifteen months, received a 12 to 15 per cent burn from a boiling coffee percolator, second degree, and two physicians were called. They were apprehensive from the beginning and the author was called to treat the child. No grease had been applied; tannic acid and silver nitrate were applied and the surface kept dry. The burn was all healed except two small areas when the child developed aphthous stomatitis and died on the fourteenth day. There was a questionable history that some other member of the family had a similar condition a short time previously. Aphthous stomatitis in a burned patient determined the outcome.

Case VI. R. J., female, age seven years, received a third degree fire burn covering 55 per cent of her body surface. The mother telephoned to the family physician who advised the application of vaseline and the sending of the child to the hospital. The area burned was from the hairline in back to the crease of the buttocks, and in front from the mouth to the pubes, laterally from the ears to the middle one-half of the thighs and the arms and forearms also were burned on all surfaces. Despite the fact that an effort was made to remove the vaseline, the surface could not be kept dry even with good nursing and the surface became covered with infection. As soon as possible the surface was prepared and skin was grafted from her father. That afternoon there was a rise in temperature and unknown to the author the child was given sulfapyridine in rather large dosage as this drug had just come on the



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FIGS. 1, 2, AND 3. CASE VI. R. S., age seven years, 55 per cent fire burn. Figure 1 as seen from the left; the coagulum is dry and clean. Figure 2 is the front view; the patient is holding on to upturned cradle. Figure 3 is the same as Figure 1, showing the areas from which the coagulum has come away and which have healed beneath. The remaining coagulum continues dry and clean. Sulfapyridine delayed healing of the grafts. The patient died on the forty-second day.

market. When the dressings were changed on the ninth day, it was found that not one graft had taken. It is believed that the sulfapyridine, slowing up healing as it does, took from this child the one chance it had of recovery. She died on the forty-second day.

Case VII. P. A. H., female, age three years, received a 40 per cent second and third degree burn of the body from a hot alkali solution. She was brought to the hospital five hours later after a ride of fifty miles and died three hours after arrival, eight hours after the accident. When the blebs were removed the characteristic red and pink mottling of alkali

	Name		Age	Per Cent	Time Seen	First Aid Treat.	De-gree	Place	Time of Death	Burned by	Cause of Death	Mori-bund or Died of Ex-tra-neous Cause
1	EDY	F	2½	1	2 hr.	TASN	2	City	3 day	Hot stove lid	Meningitis	yes
2	JB	M	40	35	2 hr.	TASN	2–3	City	3 day	Tar	Wanted to die	yes
3	FH	F	2	4	2 hr.	Grease	2–3	City	21 day	Fire	Alkalosis—soda 8 teaspoonfuls	yes
4	EB	M	84	1	1st day	TASN	2	City	10 day	Water	Pneumonia	yes
5	JC	M	1¼	12–15	2 hr.	TASN	2	City	14 day	Coffee	Aphthous stomatitis	no
6	RJ	F	7	55	2 hr.	Vaseline	3	City	42 day	Fire	Sepsis, sulfapyridine (?)	no
7	PAH	F	3	40	5 hr.	.....	2–3	50 miles	8 hr.	Hot Alkali Sol.	Measles, unresolved pneumonia, cyanotic	yes
8	RR	F	2½	50	3 hr.	Soda Bicarb.	3	30 miles	6 hr.	Alkali Fire	Shock when seen	yes
9	MM	F	3½	70	3 hr.	TASN	3	40 miles	6 hr.	Fire	Shock when seen	yes
10	IA	F	35	80	6 hr.	TASN	3	City	11 hr.	Fire	Shock when seen	yes
11	AF	F	7	75	1 hr.	TASN	3	City	2 hr.	Fire	½ gr. morph. sulphate	yes
12	WJ	M	55	5	1 hr.	TASN	2–3	City	11 day	Tar	Diphtheria	yes
13	VT	F	92	95	2 hr.	TASN	2–3	City	7 hr.	Fire	Age and extent, shock	yes
14	RHM	M	77	80	2 hr.	TASN	2–3	City	8 hr.	Tar	Age and extent, shock	yes
15	CTJ	M	26	60	3 hr.	TASN	3	40 miles	5 hr.	Electric	Extent and morph. 3 gr., shock, comp. fracture	yes
16	NP	M	2	55	1 hr.	Grease	2	City	11 day	Water	Sepsis, aphthous stomatitis, insufficient nursing	no
17	RH	M	4	80	2 hr.	TASN	2–3	City	6 hr.	Fire	Extent, shock when first seen, moved to another hospital	yes
18	JW	F	75	95	1½ hr.	TASN	2–3	City	3½ hr.	Fire	Age and extent, shock and blind	yes
19	G	M	52	25	3 hr.	None	2–3	50 miles	18 hr.	Acetylene Explosion	Comp. fracture and burn; secondary shock	no
20	NP	F	23	98	4 hr.	TASN	3	Out of City	6 hr.	Gasoline explosion	Extent	yes
21	HW	M	46	80	1 hr.	TASN	2–3	City	5 hr.	Acetylene Explosion	Extent and shock	yes
22	JJ	F	5½	70	17 days	TASN	2–3	City	80 days	Fire	Sepsis	no
23	DM	F	30	65	3 hr.	Unguentine	2–3	26 miles	67 days	Fire	Sepsis due to lack of nursing care	no

Table tabulates the details of the 23 patients who died. TASN-tannic acid and silver nitrate.

burns was seen. It was also noted when the tannic acid and silver nitrate were applied, that the coagulum took on an opalescent sheen.

Case IX. M. M., female, three and one-half years, received a 70 per cent third degree fire burn of the body forty miles away and was

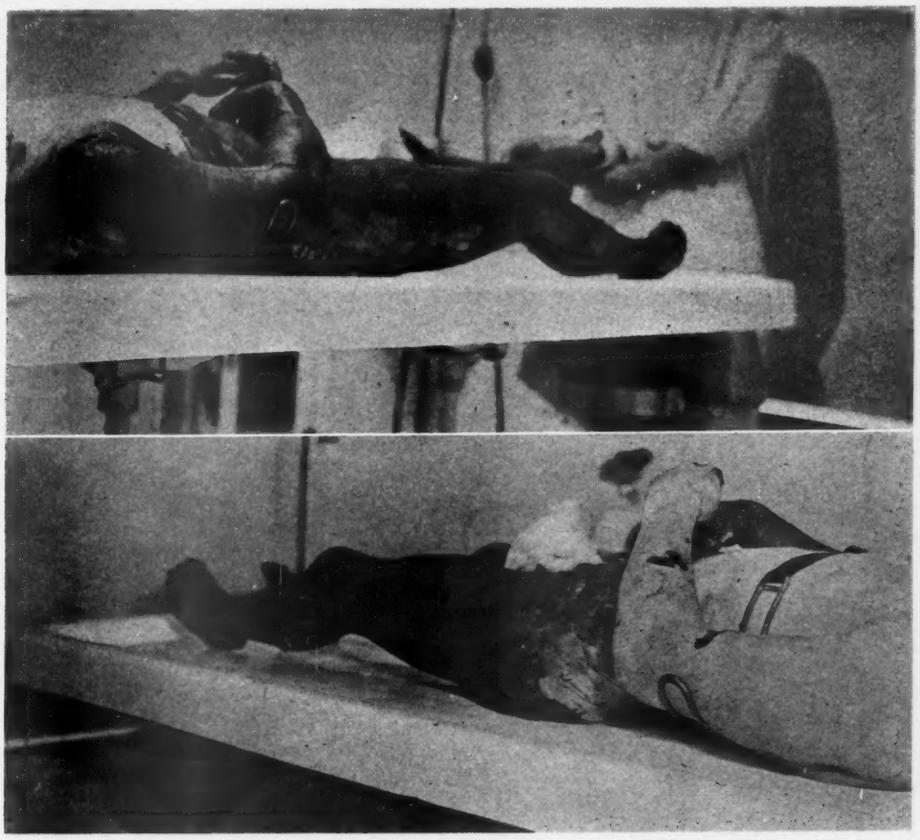

Fig. 4.

Fig. 5.

Figs. 4 and 5. Case XV. C. T. J., age twenty-six years, received a 70 per cent electrical burn with other injuries. Figure 4 shows patient viewed from the right; Figure 5 shows patient viewed from the left. This patient died five hours after injury.

This has been observed in other patients who have been burned by alkali solutions. The history and the autopsy revealed that the child had had measles recently with an unresolved pneumonia present. She was cyanotic when she entered the hospital.

Case VIII. R. R., female, age two and one-half years, received a 50 per cent, third degree, fire burn three hours before she was seen. She came from about thirty miles out of the city, was in deep shock when she arrived and died six hours after the accident, three hours after entering the hospital. Here again the opalescent sheen was seen. The extent of the burn was increased by the application at home of large quantities of dry bicarbonate of soda. This was noted in the wide extent from which the superficial skin came away, far beyond the areas which were burned by the fire, and which showed the pink and red mottling.

brought to the hospital three hours after the accident. She was in deep shock when seen having received no treatment whatsoever nor fluids, except a narcotic, until she arrived at the hospital. She died three hours after arriving or six hours after having been burned.

Case X. I. A., female, age thirty-five years, received an 80 per cent, third degree, fire burn of her body. Tannic acid and silver nitrate were applied with drying, but she died eleven hours after the accident being in deep shock when first seen. This burn was very extensive and she was not seen until six hours after the accident. Furthermore, the room in which she was treated could not be made warm nor could the patient be kept warm under the conditions presenting at the place of treatment.

Case XI. A. F., female, age seven years, received a burn covering 75 per cent of her body surface when her clothes caught fire. She was

seen one hour after the burn. The author arrived at the hospital just as the ambulance drivers were placing her on the bed. When asked what medication she had received, as her respirations were not good, they stated that they had stopped at the emergency hospital and that she had received ¼ gr. morphine there. She died one hour later. The next morning the physician who had sent her to the hospital stated that he had given her ¼ gr. morphine. This child of seven years received ½ gr. of morphine sulphate.

Fig. 6.

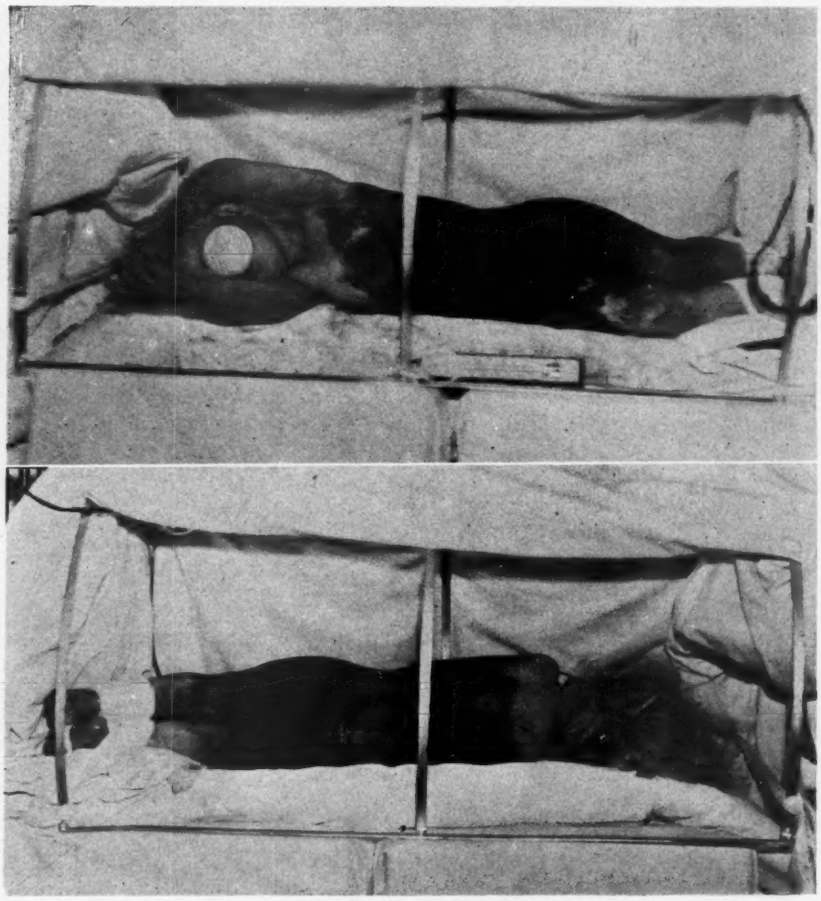

Fig. 7.

Figs. 6 and 7. Case xvi. N. P., age two years, received a 55 per cent fire burn. The child is shown in an electric lighted cradle. Figure 6 is front view; Figure 7 the back view. This patient died on the eleventh day.

Fig. 8. Case xxii. J. J., five and one-half years received a 70 per cent fire burn. Patient as viewed from the back.

Case XII. W. J., male, age fifty-five years, fell, immersing his hand, forearm and arm in a container of hot tar. Two hours were required by three physicians to remove the tar so that the surface could be tanned. A satisfactory tan was obtained and he was placed in bed with a cradle and the surface satisfactorily dried. On the eighth day one of the attendants developed diphtheria. All patients had their throats cultured. This patient, however, refused to allow the intern to take a swab and when the resident attempted to obtain same he knocked him down with a blow of his fist. He developed diphtheria and despite treatment died on the eleventh day.

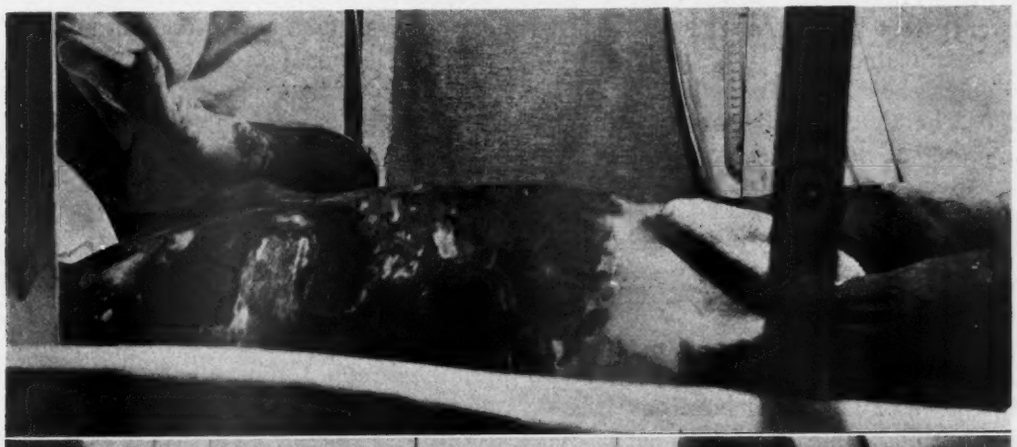

Fig. 9.

Fig. 10.

Figs. 9 and 10. Case XXIII. D. M., age thirty years, received a 65 per cent fire burn. Figure 9 shows patient as viewed from the right; Figure 10 shows patient as viewed from the left. This patient died on the sixty-seventh day.

Case XIII. V. T., female, age ninety-two years, received a fire burn which covered her body except the soles of her feet and that portion of her head which was covered by hair and the domes of each axillae. Otherwise the entire body was seared. An application of tannic acid and silver nitrate was applied two hours after the burn, fluids were given and the surface dried but the patient died seven hours after the accident of the extent of her burn and her age.

Case XIV. R. H. M., male, age seventy-seven years, received an 80 per cent burn from tar explosion. He was seen two hours after the accident and succumbed six hours later. The surface was properly tanned and dried. The cause of death was the extent of the burn in an aged man. His sister was killed outright in the explosion. When the patient learned this fact he lost the will to live.

Case XV. C. T. J., male, age twenty-six years, received a burn covering over 70 per cent of his body surface three hours before he entered the hospital and came forty miles by automobile. On the trip to the hospital it was necessary for the physician to administer 1 gr. doses of morphine sulphate on three occasions

in order to give any comfort at all. This was an electric burn; the patient came in contact with 115,000 volts at 7½ amperes, fell onto a network of high power wires, then to the ground about twenty feet below. All the tissues were burned below a line roughly diagonally from the left hip to the right side of the neck, back and front. The tissues were so badly burned that a number of bones presented at the surface. He had a large contusion at the top of the head and a compound comminuted fracture of the inferior maxillary with widespread lacerations of the superficial tissues. His breathing was depressed and he died two hours after arriving at the hospital.

Case xvi. N. P., male, age twenty-two months, received a hot water burn covering 55 per cent of his body surface. He was seen at the hospital one hour after the accident, covered with grease. This was removed and the area was then properly tanned and dried. Despite everything that could be done, he developed sepsis and aphthous stomatitis and died on the eleventh day. The primary application of any greasy preparation definitely increases the seriousness of any burn. The unavailability of nurses added to the difficulty.

Case xvii. R. H., male, age four years, received a second and third degree fire burn covering 80 per cent of his body surface. He was taken to a hospital where the surface was properly tanned except the face. He came under our care two hours after the accident having received no anti-shock treatment other than the local applications. Fluids were started intravenously and by mouth but could not be given in large enough quantity to overcome the dehydration and the delay in starting fluids. Upon entering the hospital his hemoglobin was 117 per cent and his red blood count 6,5000,000 and three hours later the hemoglobin was 140 per cent. Add 10 to 15 per cent for age. He died four hours after entering the second hospital. This patient should have had fluids and shock overcome before he was moved from the first to the second hospital. This, at least, would have given him a chance for recovery.

Case xviii. J. W., female, age seventy-five years, received a 95 per cent, second and third degree burn when in her blind condition she set her clothes on fire from an open fireplace. She was seen one and one-half hours after the accident and although satisfactorily tanned died two hours later.

Case xix. V. G., male, age fifty-five years was burned fifty miles from Portland by the explosion of acetylene. In addition to the concussion he had a burn covering 25 per cent of his body surface and a compound fracture of the left femur. He came by automobile fifty miles and arrived in shock. The burned area was tanned, he was given fluids and was coming out of shock when the fracture was treated by an orthopedist. A plaster paris cast was applied covering the entire left leg and thigh and the left buttock, fully 30 per cent of the body surface. This large, cold, wet application to a patient not completely out of shock caused him to relapse into shock from which he could not be brought out. He died eighteen hours after the accident. Had the treatment of the fracture been delayed another twelve hours, the patient might have had a chance to survive.

Case xx. N. P., female, age twenty-three years, received third degree burns over the entire body except the top of her head. She died six hours after the accident less than two hours after coming under treatment.

Case xxi. H. W., male, age forty-six years received a second and third degree burn covering 80 per cent of his body surface from the explosion of acetylene. He was seen at the hospital one hour later and the surface was tanned and dry. The large extent of the burn together with the injury due to concussion determined the outcome. He died five hours after the accident.

Case xxii. J. J., female, age five and one-half years, received a fire burn covering 70 per cent of the body. She was seen on the seventeenth day and the coagulum was wet and had much secretion beneath it. Every effort was made to remove the coagulum as early as possible in order to skin graft the surface but she succumbed on the eightieth day. In order to keep a burned area dry, drying must be started at the beginning.

Case xxiii. D. M., female, age thirty years, received a 65 per cent fire burn. She arrived at the hospital three hours after the accident, after a ride of twenty-five miles, covered with unguentine. An honest effort was made to remove this application. It was impossible at any one time to get three nurses on the case. A serious burn requires full nursing attention for twenty-four hours a day; one nurse of eight hours cannot overcome the unfavorable conditions which develop during

the remaining sixteen. It is believed that had this patient had three nurses she might have recovered. She was skin grafted from her brother and these had taken nicely at the time of her death.

Of the twenty-three deaths, twelve, or 52 per cent, died in from two to eleven hours after having been burned and thirteen, 56.5 per cent, in the first twenty-four hours. These are the patients who were overwhelmed by their burns. No patients died on the second day. Eight died on the third to the forty-second day; of these, two on the third day, none on the fourth to the ninth day, three on the tenth and eleventh days, three from the twelfth to the forty-second day. Two died on the sixty-seventh and eightieth days, respectively.

The following died of conditions not related to the burn: Too much soda, too much morphine, will to die, pneumonia, meningitis, measles, diphtheria and compound fracture.

It is our belief that in only six was there a chance to save the patients when they were first seen, excepting, of course, those who died of extraneous conditions. The few that died of sepsis arrived at the hospital covered with grease or oil of some kind. These applications always increase the risk to the burned patient. Only one died of the many who came under our attention after the second day, on the seventeenth.

Causes of burns were: Fire caused eleven, 47 per cent, hot stovelids one, hot water or other hot liquid five, electricity one, tar three, and acetylene explosions two.

The ages were: Eleven, 47.8 per cent, who died were below seven years of age. There were no deaths between eight and twenty-two inclusive, eight were between twenty-three and seventy-four years and four were between seventy-five and ninety-two years.

As to the per cent of body surface burned:

Per Cent of Burn	No.	Cause of Death
1	2	Meningitis; pneumonia
2–5	2	Diphtheria; alkalosis
5–10	none	
11–20	1	Aphthous stomatitis
21–30	1	Concussion, fracture and cast
31–40	2	Wanted to die; measles, unresolved pneumonia
41–50	1	Shock
51–60	2	Sepsis—sulfapyridine; sepsis—aphthous stomatitis
61–70	4	Shock; extent; sepsis; lack of nursing care
71–80	5	Extent and concussion; moved without shock treatment; age and extent; too much morphine; shock
81–90	none	
91–100	3	Age and extent; age and extent; age and extent

Under the tannic acid and silver nitrate treatment with drying in a series of 744 consecutive burns, twenty-three have been lost, or 3.1 per cent. Surely a treatment which gives such a low death rate deserves a high place in the treatment of burns.*

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*Since the above was presented for publication, thirty-four additional burned patients have been treated with the death of one, a total of 778 cases with twenty-four deaths, 3.1 per cent. The latter was of a sixty-three year old woman with a 65 per cent hot water burn contracted while in a bath tub. Death took place in fifteen hours.

CONTIGUOUS SKIN FLAPS FOR WOUNDS OF THE EXTREMITIES

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THE restoration of the wounded soldier to a functioning state in the shortest period of time is the goal of all surgical officers.

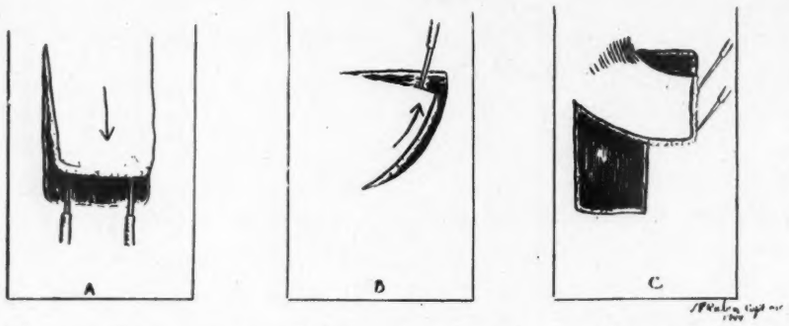

FIG. 1. Three general principles of the contiguous skin flap technic: A demonstrates advancement; B demonstrates rotation; C demonstrates transposition.

In the base sectors of overseas theatres, the secondary closure of wounds is the bulk of war surgery. The majority of wounds, since skin loss is minimal, can be closed by adequate undermining and suturing of the edges. However, there are avulsed wounds in which the loss of skin and deep tissue makes the closure seem impossible except by skin grafting. But there is another alternative to the skin graft, namely, the contiguous skin flap. This method is simply the mobilization of skin adjacent or contiguous to a wound by the use of planned incisions which permit the contiguous skin to cover the defect after advancement, rotation or transportation of the skin flap. (Fig. 1.)

The increased use of contiguous skin flap methods of closure has grown in our practice largely because of the application of penicillin protection and multiple blood transfusions for improved wound healing. Contiguous skin flaps require extensive undermining and opening of large areas of tissue to bacterial invasion, therefore, the need for penicillin and the better results therefrom. Concurrently the ideas of Colonel E. W. Churchill[1] and Major Champ Lyons[2] on the relationship of the normal blood picture and wound healing have been applied with diligence so that every wound, extensive or likely to be slow in healing, received multiple transfusions until the blood volume and hematocrit stayed normal.

Clarkson[3] has helped to renew interest in problems of extensive wound closures and has described methods of suturing after undermining and rotation.

Textbooks on surgery contain uninteresting descriptions of the technic of skin flaps, with two few and inadequate sketches. This paper attempts to summarize, with the aid of drawings, photographs and charts, our experiences with contiguous skin flaps for wounds of the extremities.

The indications for the use of this technic apply to wounds which require new skin tissue which: (1) Will cover exposed bone, tendon or deep irregular muscle defects; (2) will not adhere to underlying muscle when fascia is missing, and (3) will not contract.

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In short, wherever a skin cover containing fat is desired, the contiguous skin flap has a place. Alternatives would be tube or flap grafts.

Contiguous skin flaps have their limitations. Where the skin loss is extensive, the technic becomes impossible because skin manipulation beyond a certain point will shut off blood supply either by tension or direct severance. The flaps are best used where the skin is lax, as on the abdomen, back and face, and less easily utilized on the arms, forearms, thighs and legs. The lateral aspects of the thigh and legs do not readily lend themselves to the procedure. It is almost impossible to use the technic on the soles of the feet, very difficult on the palms of the hand.

GENERAL TECHNIC

Granulation tissue is excised completely and a fresh skin margin prepared. Planned new incisions are made and then the flaps are undermined. The flaps must contain all layers of fat down to deep fascia. Undermining is continued until the wound can be closed by bringing the edges together. The question arising immediately is how much undermining and how much stretching one can do before there is loss of viability. Figures quoted by Clarkson[3] have, on the whole, coincided with our series. "In the leg, below the level of the bellies of the calf muscles, 4 cm. is safe. As one goes higher in the limb, the figures become 7 and 8 cm. In the arm and upper forearm, 8 to 10 cm. can be undermined."

Fairly large defects can be closed, depending upon the location and the direction of the wound. In the extremities, a wound running transversely is more difficult to close than one in a longitudinal direction. Thus, a transverse wound 3 cm. wide, on the lateral aspect of the leg will require extensive undermining. A similar wound on the lateral aspect of the thigh will also present difficulties. But, a defect 25 by 14 cm. in a longitudinal direction up and down the thigh will close easily. No invariable rule can be laid down. A study of our cases in Table 1 will give some idea of the sizes of the wounds closed. We know of no method of determining the limits of safe closure other than the use of clinical judgment.

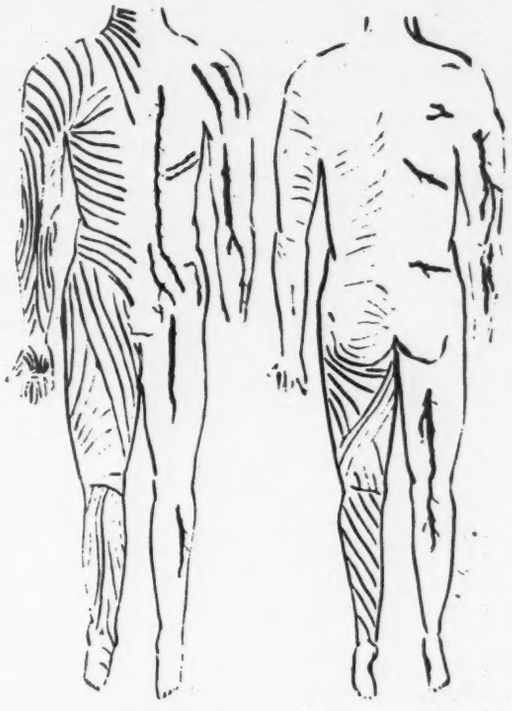

Fig. 2. Illustration of Langer's lines and of principal blood vessels supplying skin areas.

Buried non-absorbable sutures are not employed. Deep sutures, to take the tension off the edges, are of plain catgut No. 00, and, where delicate flaps are used, of No. 0000 on atraumatic needles.

Plaster of Paris splints are applied after operation and retained until we remove the superficial cotton sutures, usually about the tenth day.

To facilitate the description and planning of the surgery, we have made use of the standard ways of transforming irregular wounds into geometric designs, such as triangles and rectangles, and have planned the closures to give figures H, Y, T, Z, etc. Planned incisions wherever possible should be made along Langers lines. (Fig. 2.) The study of Langers lines or the natural skin lines will repay the surgeon with finer skin scars and more rapid healing.

TABLE I

CASE SUMMARIES—CONTIGUOUS FLAP CLOSURES

Case No.	Anatomical Site	Size cm.	Age of Wounds in Days	Direction of Wound	Type of Closure	Remarks
1	Buttock	30 by 15½	28	Transverse	Rotation T Plastic	Uneventful
2	Buttock	15 by 11	44	Transverse	Rotation T Plastic	Uneventful
3	Buttock	15 by 10	27	Transverse	Rotation T Plastic	Wound closed with deep layer of buried cotton sutures. Wound edge broke down and yielded Staph. albus, B. Pyocyaneus and C. hoffmani. Drainage persisted until wound edge was excised and all cotton removed. Resuturing was followed by healing.
4	Buttock and hip	12 by 10	36	Transverse	Rotation T Plastic	Marked muscle loss Necrosis about a few sutures. Upon walking, a small area over the hip broke down. Hem. staph found on culture. Small split skin graft placed over the defect with healing.
5	Buttock and hip	24 by 10	11	Longitudinal	Rotation T Plastic	Marked loss of muscle substance. Rotation followed by cellulitis and then abscess formation. Culture yielded hem. strep. and pyocyaneus. Under wet dressing and dependent drainage wound healed.
6	Buttock and thigh post.	10 by 7	13	Longitudinal	Rotation T Plastic	Uneventful
7	Thigh	28 by 11	12	Longitudinal	Advancement	Slight suture necrosis. Then uneventful healing.
8	Hip and thigh	20 by 8	...	Longitudinal	Advancement	Uneventful
9	Thigh post.	6 by 14	69	Transverse	Advancement U Plastic	Uneventful
10	Thigh post. just above popliteal space	4 by 10	13	Transverse	Advancement U Plastic	Flap was delayed twice because of size of flap and color changes at time of raising. After wound closed lateral margin broke down. Four days later margin excised, resutured and healed.
11	Thigh post. middle ⅓	6 by 12	53	Transverse	Advancement U Plastic	Uneventful
12	Leg post.	8 by 5	9	Oblique	Advancement	Uneventful
13	Leg post.	12 by 5	24	Transverse chevron shape	Advancement Y Plastic	Uneventful
14	Leg medial	18 by 5	51	Longitudinal	Advancement Y Plastic	Uneventful
15	Leg lateral	10 by 5	...	Longitudinal	Advancement	Uneventful
16	Leg posterior	9 by 4	...	Longitudinal	Advancement	Uneventful
17	Leg lateral	3 by 5	24	Transverse	Rotation T Plastic	Uneventful. Marked edema persisted for a month after patient began to walk. Subsided after two months.

TABLE I (*Continued*)

Case No.	Anatomical Site	Size cm.	Age of Wounds in Days	Direction of Wound	Type of Closure	Remarks
18	Leg anteriorly upper ⅓ tibia exposed	2 by 4	57	Transverse	Transposition	Flap raised and delayed two times. Part of distal edge necrotized due to ischemia. Flap transposed at the third operation with final healing.
19	Leg ant. upper ⅓ tibia exposed	4 by 4	245	Circular	Transposition	Flap delayed two times and then transposed. Site of donor flap split-skin grafted.
20	Leg ant. middle ⅓ tibia exposed	7 by 5	68	Longitudinal	Transposition	Flap delayed two times. Marked cellulitis followed first raising, leading to frank pus. Culture grew Staphaureus, Cacnes and paracolon. Wet dressing cleared infection. Three weeks elapsed between first and second delaying stages. Site of donor flap covered with a split-skin graft.
21	Leg ant. tibia exposed	10 by 3	25	Transverse	Rotation and Advancement Y Plastic	Suture necrosis cleared by wet dressings.
22	Leg lateral to knee	4 by 3	73	Transverse	Advancement Y Plastic	Wound broken down about sutures. Cultures yielded Staph hem. Healed under wet dressings.
23	Leg lateral aspect	11 by 5	25	Longitudinal	Advancement Y Plastic Relaxing Incisions	Superficial suture necrosis healed under wet dressings. Edema of the leg, persistent when patient began to walk.
24	Leg post. ⅓ lower exposed infected tendon	3 by 8	25	Transverse	Advancement	Flap was raised and delayed. It was followed by marked infection. Culture grew Clostridium Chauvoei, Anaerobic Strep, and Staphalbus and B. Pyocyaneus Six cm. of the flap necrotized. The tendon slough was severe. After three weeks of azochloramid dressings a split skin graft was laid over the granulation wound with complete healing.
25	Leg post. lower ⅓ exposed Achilles tendon	6 by 6	32	Transverse	Transposition	Flap was delayed three times. Circulation remained very poor. The distal end of the flap continued to slough each time. It became apparent that the defect could not be closed by transposition a flap graft was raised from the opposite thigh
26	Leg lateral aspect	3 by 7	4	Transverse	Advancement H Plastic	Superficial suture necrosis. Healed with wet dressings.
27	Leg post. aspect mid ⅓	6 by 10	23	Transverse	Advancement H Plastic	Distal and proximal flaps delayed. Distal end of proximal flap became necrotic and purulent. Culture grew Straph. aureus and B. proteus. Azochloramid dressings for two weeks. Granulations filled the marked gastrocnemius defects and a split-skin graft was applied two weeks later.

TABLE I (*Continued*)

Case No.	Anatomical Site	Size cm.	Age of Wounds in Days	Direction of Wound	Type of Closure	Remarks
28	Post. axillary fold contracted scar broken down	14 by 2	75	Longitudinal	"z" Plastic	Flaps delayed. Sutured into position six days later.
29	Post axillary fold contracted scar broken down	15 by 1	55	Longitudinal	"z" Plastic	Few suture necrosis areas. Healed with good function.
30	Antecubital space open wound	14 by 4	26	Longitudinal	"z" Plastic	One stage. Hem. strep. infection followed. Wound opened, wet dressings applied. Wound resutured with complete healing.
31	Antecubital space contracted broken down wound	10 by 2½	120	Longitudinal	"z" Plastic	One stage. Uneventful
32	Antecubital space contracted broken down wound	18 by 2	63	Longitudinal	"z" Plastic	One stage. Distal tip became necrotic but healing under wet dressing gave a good functional result.
33	Antecubital space contracted broken down wound	12 by 2½	65	Longitudinal	"z" Plastic	One stage. Uneventful.
34	Antecubital space contracted broken down wound	5 by 1	60	Longitudinal	"z" Plastic	One stage. Uneventful
35	Antecubital space open wound	12 by 4	16	Longitudinal	"z" Plastic	Two-stage delayed procedure. Distal tip became necrotic after 2nd stage. Extensive undermining had been necessary. Under wet dressings the defect healed in two weeks with good function.
36	Antecubital space open wound	14 by 4½	7	Longitudinal	"z" Plastic	Two stage delayed procedure. Both flaps became cyanotic after transposition with a superficial corneum peeling. Healed completely under wet dressings.
37	Palm of hand. Contracted scar across distal crease	3 by ½	37	Longitudinal	"z" Plastic	Uneventful
38	Groin open cont. wound following old closure	6 by 3	120	Longitudinal	"z" Plastic	One stage. Flaps were of poor texture and broke down upon walking. Area was completely excised and split skin graft applied.
39	Groin cont. scar	5 by 3	110	Longitudinal	"z" Plastic	One stage. Wound broke down. In purulent discharge, culture grew pyocyaneus, staph albus hem, and corynbacterium exerose. After a week of wet dressings; a split skin graft was applied with complete take and good function.
40	Popliteal space open wound	14 by 5	23	Longitudinal	Multiple Plastic	Superficial suture necrosis which healed under wet dressins.
41	Popliteal space open wound	11 by 3	21	Longitudinal	"z" Plastic	Two stage delayed flap procedure. Attempted closure, with one stage flap became cynotic. At second stage a paravertebral block was given after the procedure. Some distal edge necrosis but under wet dressings, healed.

TABLE I (*Continued*)

Case No.	Anatomical Site	Size cm.	Age of Wounds in Days	Direction of Wound	Type of Closure	Remarks
42	Popliteal space contracted broken down wound	12 by 1½	110	Longitudinal	"z" Plastic	One-stage. Lumbar paravertebral block done after procedure. Distal flap tip became necrotic but healed with wet dressings.
43	Popliteal space contracted broken down wound	11 by 2	140	Longitudinal	"z" Plastic	Two-stage procedure. Lumbar paravertebral block performed at time of second operation. Uneventful healing.
44	Popliteal space contracted broken down wound	12 by 3	109	Longitudinal	"z" Plastic	One-stage procedure. Flaps broke down. Culture grew staph albus and pyocyaneus. Azochloramid dressing cleared infection and two weeks later a split skin graft was applied. Complete take with good result.
45	Arm medial aspect middle ⅓	4 by 3	39	Transverse	Rotation T Plastic	Uneventful closure.
46	Forearm, lower ⅓	15 by 6	29	Longitudinal	Advancement	Ulna exposed. Despit marked undermining, wound could not be safely closed. Bone was covered and wound partially sutured. Split-skin graft week later completed the closure.
47	Forearm	8 by 4	23	Longitudinal	Advancement	Uneventful closure
48	Wrist	4 by 5	7	Transverse	Advancement and rotation Y Plastic	Uneventful closure
49	Ankle	3 by 4	191	Longitudinal	Rotation T Plastic	Delayed procedure. After closure at the 2nd stage, wound broke down with a marked hemolytic strep infection. The flaps became necrotic and sloughed. The wound was eventually closed by a flap graft from the opposite thigh.
50	Foot Planter and lateral aspects	6 by 1½	7	Longitudinal	Advancement	Uneventful closure.

The following diagrams and final photographs illustrate the more specific and fine details of technique: (Figs. 3 to 12.)

COMMENTS

Circulation. No flap can exist without its blood supply, arterial and venous. Undermining and elevation of a flap destroy the vascular supply, and require that new channels be formed of sufficient degree to maintain circulation. To avoid ischemia we stress the importance of a thick flap. Figure 14 illustrates large blood vessels coursing through the fatty areolar tissue under the corium. These vessels send small branches up in straight lines to form anastomosing plexuses in the corium. To insure complete blood supply, one must include in the flap all layers of tissue, especially all of the fat down to the fascia.

Every surgeon doing wound closures must familiarize himself with the direction of blood vessels, as shown in Figure 2. Illustrations can be found in every standard textbook. If possible, each flap should include a fair sized vessel. At times, however, the position of the flaps will necessitate cutting across main sources of blood supply. To maintain the viability of the flap, we employ the technique of "delaying," which

uses the principle of a gradual, rather than a sudden, reduction of blood supply. In our problem, the flap, after being outlined in its former position. The cutting of blood supply from the edges and from the bottom will force dilatation and enlargement of

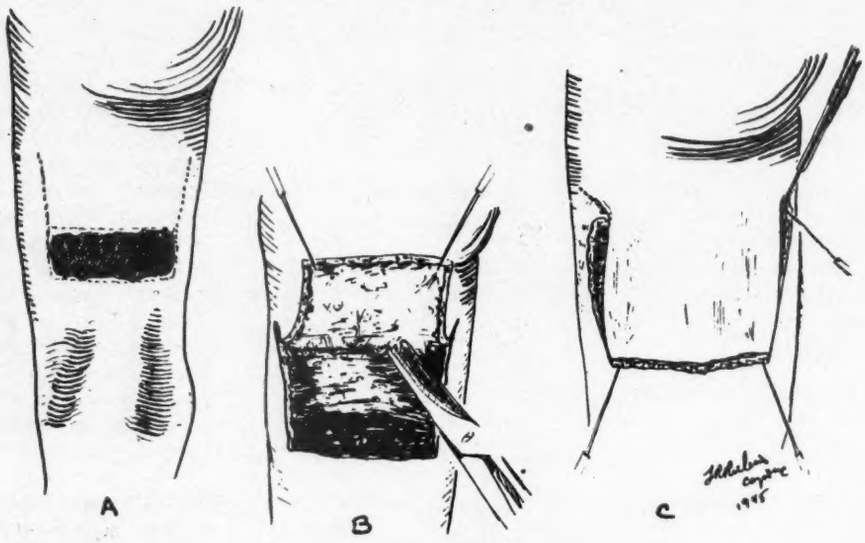

FIG. 3A, B and C.

FIG. 3D.

FIG. 3. A TO D, advancement single flap U closure for rectangular wound. Location and direction: Posterior aspect of thigh, transverse direction. Size: 14 cm. by 6 cm. Deep hamstring muscle loss. Proximal flap included all layers of fat down to fascia. Advancement with No. 00 plain catgut buried to relieve edge tension. Tension and puckering at proximal part of the flap was relieved by the removal of Burow's triangles.

through the skin, subcutaneous tissue and fat, is completely lifted from its bed, only to be replaced immediately and resutured blood vessels at the base. These vessels array themselves longitudinally and so enhance circulation for the eventual trans-

fer. This takes a minimal time of five to seven days. Even if some sloughing were to develop later, it would be less than if the flap were not raised. If, at the end of seven days, the flap is raised again and one is still worried about the circulation, the same procedure should be repeated. This may necessitate several stage operations. However, the total time required for multiple stage operations is much less than it would be lost if a failure were to occur and other procedures started.

The choice of anesthesia is most important from the view point of circulation. Local anesthesia, even without adrenalin, should never be used. Adrenalin is definitely contraindicated because of vasoconscriction. The presence of novocaine in the tissues gives us a mechanical barrier of fluid, compressing the capillaries. Thus we

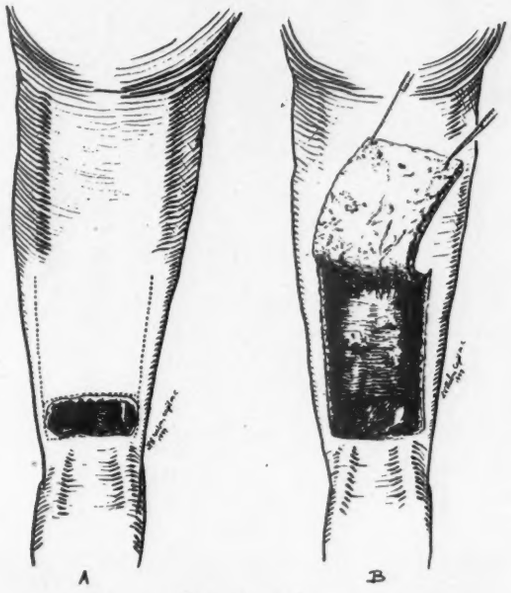

Fig. 4A and B.

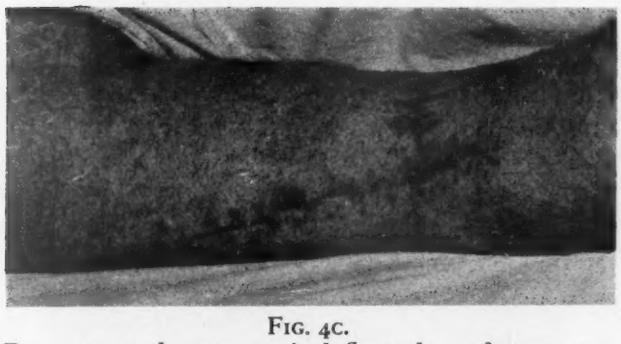

Fig. 4C.

Fig. 4. A to C, advancement single flap U closure for rectangular wound. Location and direction: Suprapopliteal space, transverse direction. Size: 5 cm. by 9 cm. Illustration demonstrates a suprapopliteal wound with exposure of tendons. After a conversion to a rectangular shape, a 15 cm. proximal flap was raised and delayed. Seven days later, flap was elevated again and wound closed. A narrow margin laterally necrotized, and to avoid prolonged healing, this necrotic edge was excised and easily closed. Wound healed uneventfully. Total time for repair was twenty days.

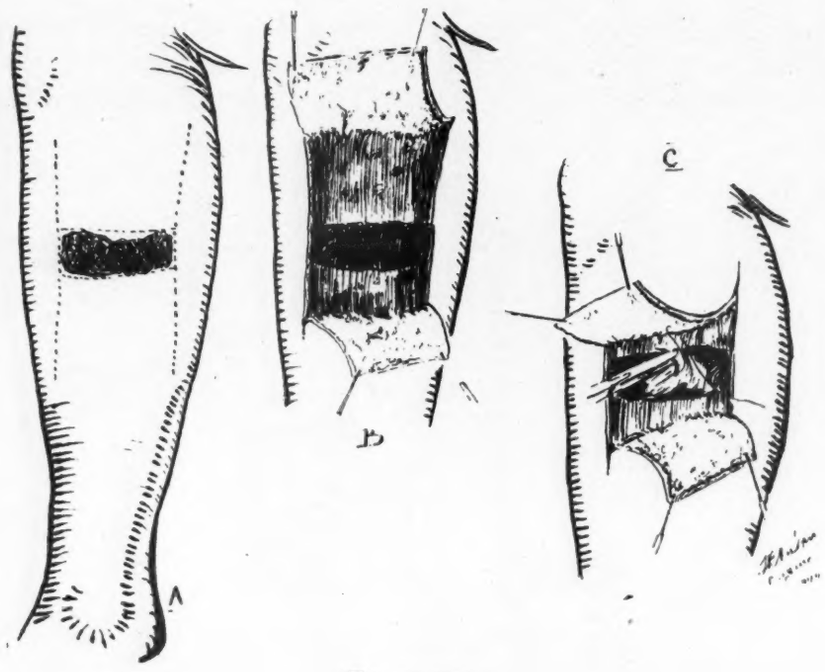

FIG. 5A to C.

FIG. 5D.

FIG. 5. A to D, advancement two flap H closure for rectangular wound. Location and direction: Lateral aspect of leg, transverse direction. Size: 3 cm. by 7 cm. Marked muscle loss was present. Wound edge was converted to a rectangle. New incisions down to fascia were made and two flaps proximal and distal to the wound were raised. Proximal flap was 7 cm. long and distal was 6 cm. long. Flaps were delayed. Six days later both flaps were elevated and advanced. No. 00 plain catgut was used for the deep advancing sutures. There was superficial necrosis at the edges of the flaps, but after the sutures were removed on the twelfth day, the necrotic areas healed rapidly under wet dressings.

get constriction, despite the vasodilating action of novocaine without adrenalin. Wherever possible, brachial block for the arms and spinal anesthesia for the lower extremities are the choice. These are preferred because they ensure maximum vasodilation during, and for a significant period after the operation. The time immediately after the elevation of the flap is the critical period. It is then that the circulation is in need of the greatest possible aid and must be watched.

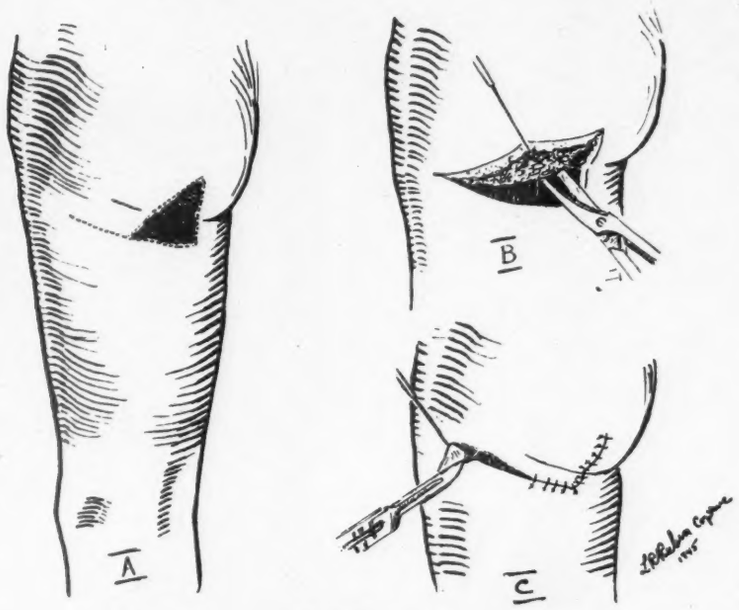

Fig. 6A to C.

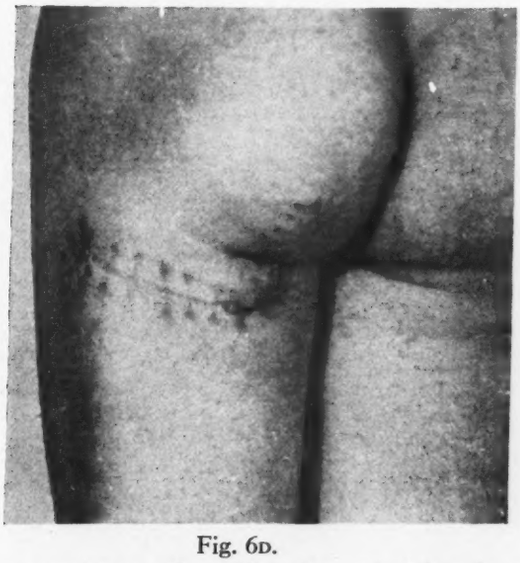

Fig. 6D.

Fig. 6. A to D, rotation L closure for triangular defect. Location and direction: Posterior medial aspect of buttock and thigh, longitudinal direction. Size: 7 cm. by 10 cm. The loss of tissue included the hamstring and gluteals. Because of the proximity of the wound to the rectum, a one-sided flap was raised laterally. The flap was very thick and since the circulation was adequate with the thick layer of accompanying fat, the defect was closed in one stage by rotation. Tension and puckering at the lateral angle was removed by excising a triangle known as a Burow's triangle.

Yet another factor to be considered is the presence of vasomotor spasm encountered in certain individuals. Some people lumbar. If an adequate increase of circulation follows, without skin anesthesia, the effect is prolonged by the injection of 2 cc.

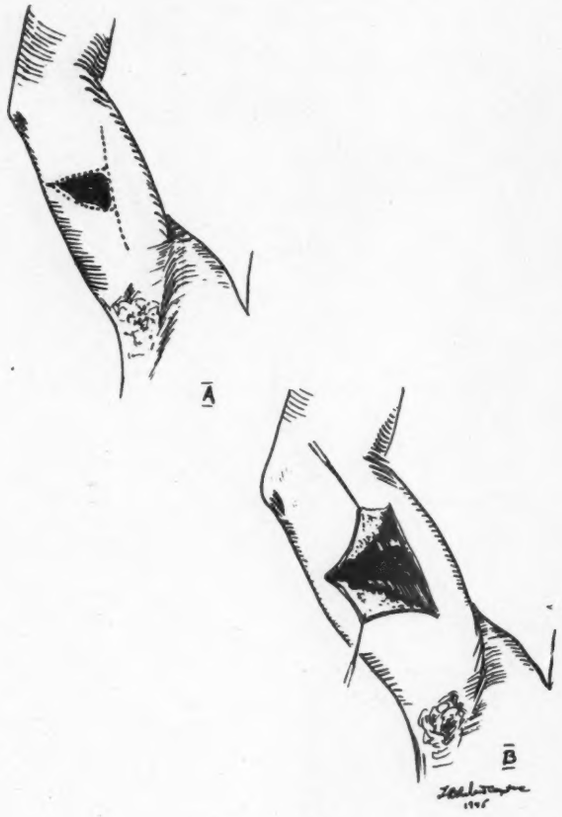

FIG. 7A and B.

FIG. 7C.

FIG. 7. A to C, rotation two flap T closure for triangular wound. Location and direction: Medial aspect of midarm, transverse direction. Size: 4 cm. by 3 cm. Two previous unsuccessful attempts at simple closure. Two flaps raised, extensive undermining, and flaps then rotated and closed in one stage. Two Burow's triangles were removed at both ends of the horizontal bar of the T to allow for puckering (*x* in figure C).

have a high vascular tone and are sensitive to the vasoconstrictive effects of cold, pain and trauma. As a result of the original trauma, these individuals frequently exhibit either localized or generalized form of pallor, coldness, cyanosia, or excessive sweating. The additional surgical injury of extensive flap lifting may be followed by a serious increase of vascular constriction, so serious as to cause necrosis in places where least expected. Excessive vasoconstriction is often seen in the legs.

To deal with this condition we have made use of the paravertebral sympathetic block. Five cc. of 2 per cent novocaine is injected into each of the paravertebral areas, usually the second, third and fourth of 95 per cent alcohol through each needle. We do not use alcohol in the stellate blocks of the upper extremity in order to avoid the possibility of a permanent Horner's syndrome and because repetition of a stellate block is easy and practically painless.

The question of heat in circulation increase should be briefly discussed. The application of heat increases circulation. The recent work has shown, however, that heat applied directly to a part with a deficient circulation, increases the metabolic needs of the part far greater than it increases the blood supply. In short, the direct heating of an ischemic area favors necrosis. Heat is beneficial nevertheless, when applied to the trunk of the body, so as

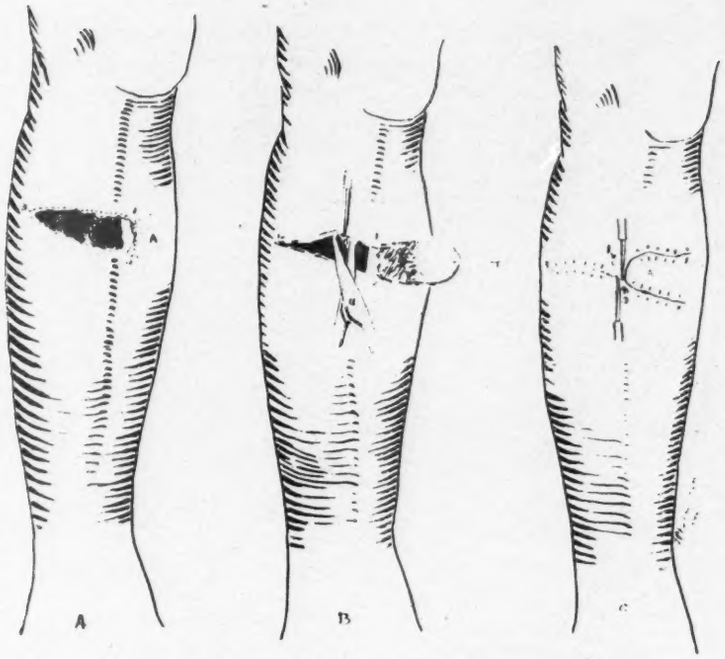

FIG. 8A TO C.

FIG. 8D.

FIG. 8. A TO D, combined rotation and advancement Y closure for triangular wound with exposed tibia. Location and direction: Middle third of leg over tibia, transverse direction. Size: 3 cm. by 10 cm. Tibia edge was exposed and there was a loss of peroneal muscle tissue. After extensive undermining, medially directed incisions elevated a thick flap which was advanced laterally to cover bone defect. Wound was then closed by rotating the proximal and distal flaps. The moderate amount of tension present accounted for the superficial skin necrosis which healed after the sutures were removed.

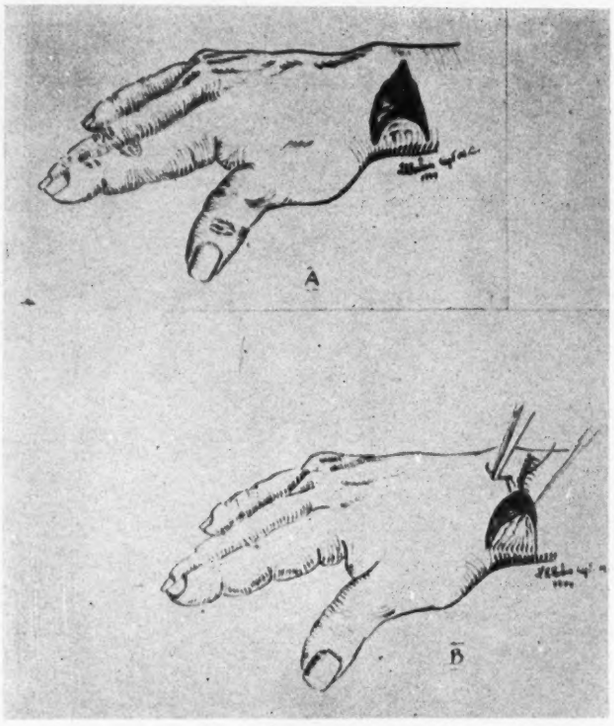

FIG. 9A.

FIG. 9B.

FIG. 9. A and B, combined rotation and advancement Y closure for triangular defect. Location and direction: Radial and dorsal aspects of wrist, transverse direction. Size: 4 cm. by 5 cm. Wound edges trimmed and extensive undermining done. One radial flap extended and advanced to complete a Y closure.

to obtain reflex vasodilatation in the extremities without increasing the metabolic needs of the tissues compromised by the surgery and wound.

Nerve Complications. At the present time the concept of early surgical repair of nerve lesions must be a deciding factor in choosing the best method of wound closure. Since the wound must be closed as soon as possible, the neurosurgeon should be consulted about the procedure which will make his eventual repair easier. If

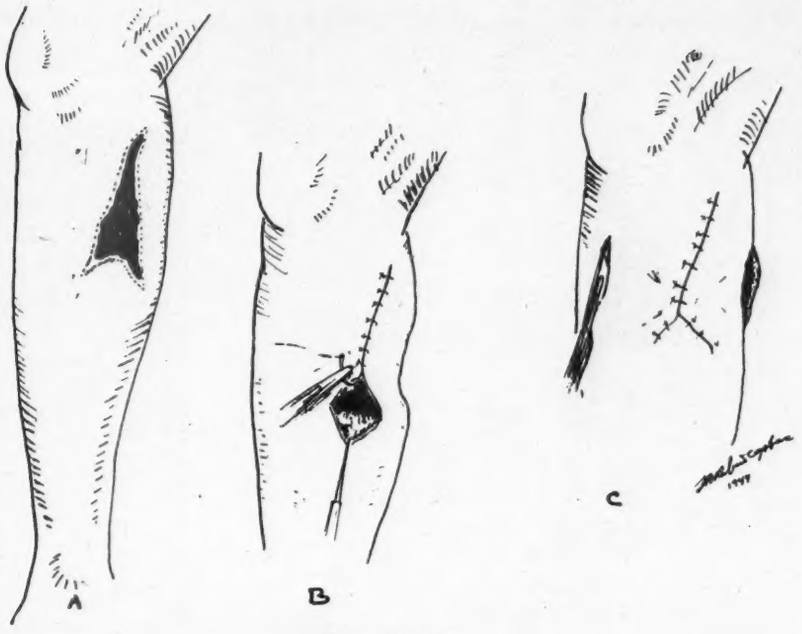

Fig. 10A to C.

Fig. 10D.

Fig. 10. A to D, combined rotation and advancement Y closure with relaxing incisions for a triangular defect. Location and direction: Posterolateral aspect of leg, middle third, longitudinal direction. Size: 11 cm. by 5 cm Deep tissue loss of peroneal muscle. Y wound closure left considerable tension. Two incisions were made through the skin through the areas of greatest tension. This left two gaping wounds but relieved the tension. Two weeks later the incisions were secondarily closed.

extensive flap repairs are to be done in the presence of a nerve lesion, it might be a better plan to use a split skin cover immediately. This would avoid any scarring which might make the neurosurgical task more difficult. If necessary, the split skin can be excised after the nerve repair and the appropriate skin flap applied.

Infection. The presence of gross infection will break down the best repair. All of our wounds were contaminated, many definitely infected. The use of penicillin has diminished the virulence of the bacteria present and prevented the spread of infection through tissues laid open by surgery. The identification of various organisms has not helped us much except in certain categories, such as the Streptococcus and gas bacillus strains, in association with which tissue necrosis surely followed.

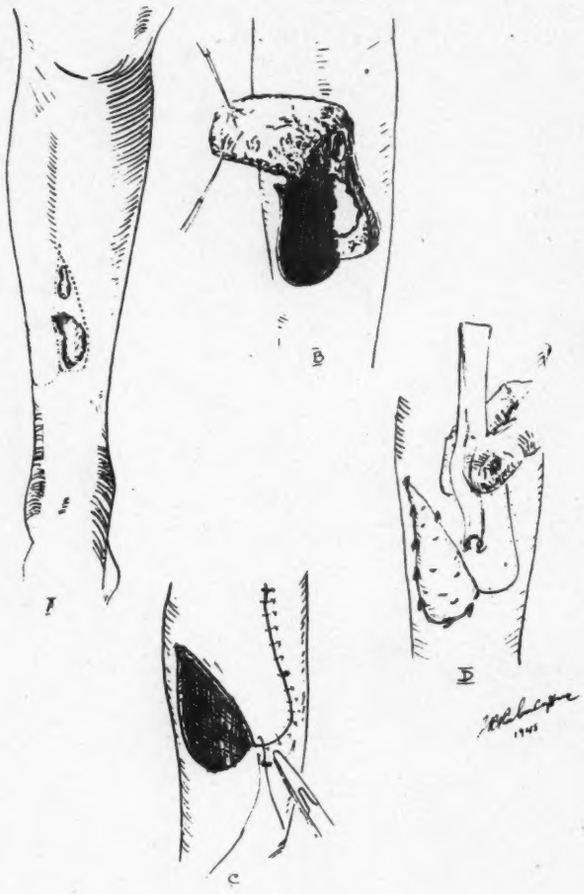

FIG. 11A to D.

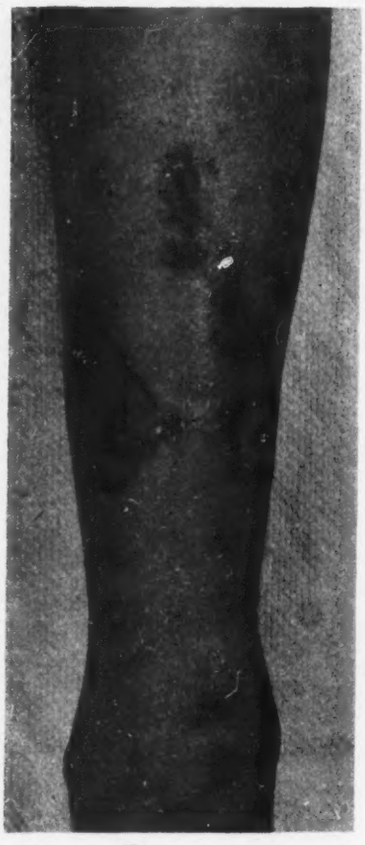

FIG. 11E.

FIG. 11. A to E, transposition closure for irregular ovoid wound with exposed tibia. Location and direction: Middle third of leg, over tibia, longitudinal direction. Size: 7.5 cm. by 5 cm. The exposed tibia prevented wound healing for four months. A flap was raised and delayed. It was followed by a Streptococcus hemolyticus cellulitis several days later. Wet dressings were applied and ten days later the flap was raised and delayed once more. The final transposition was made ofter another six days and the wound was covered. The defect left by the transposed flap was covered, after two weeks by a split skin graft, using the gum acacia technic.[5]

In other wounds, we are certain some of the necrosis found at the wound edges had its cause in tissue breakdown by bacteria even though they were of the secondary invader type, such as Staphylococcus albus, pyocyaneus and the cornybacterium groups.

Tension. In the attempt to close a wound, there is a tendency to use towel clips, forcing the wound edges together and then suturing. Necrosis naturally follows. To avoid the tension we undermine freely

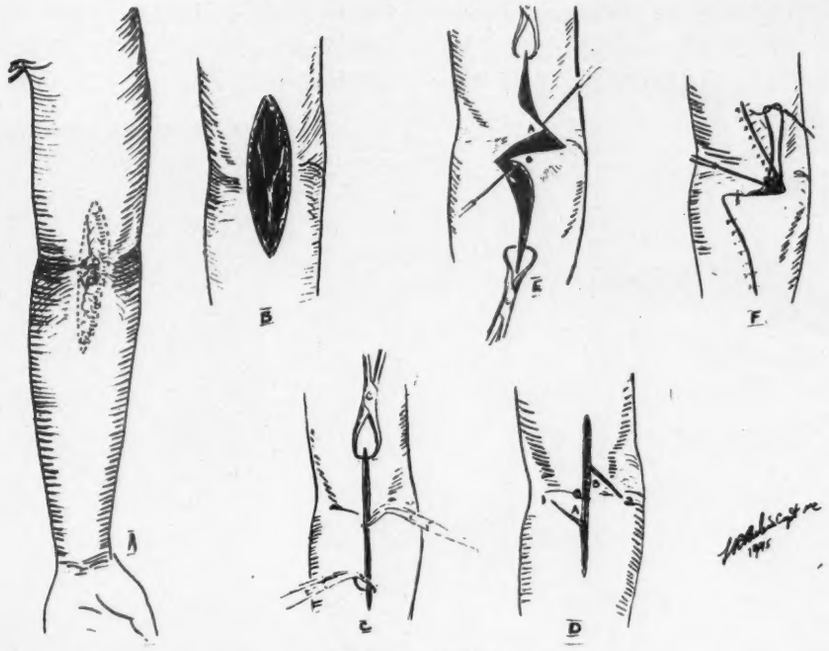

FIG. 12A TO F.

FIG. 12G.

FIG. 12. A to G, Z plastic transposition for ulcerated contracted wound. Location and direction: Antecubital space, vertical direction. Size: 10 cm. by 2½ cm. Contracted ulcerated wound of four month's duration. Elbow extension limited to 130 degrees. Z plastic procedure was chosen because of position and comparatively narrow wound. B, shows gaping after excision of cicatrical wound. C, illustrates formation of a vertical straight wound after extensive undermining has permitted an easy closure without tension. It was necessary to undermine about three-quarters around the elbow. Where the horizontal joint crease crosses the vertical wound, the point O is placed. D, shows the two parallel incisions 1A and 2B, through all layers of skin and fat, each 60 degrees with the vertical. The ends of the lines do not extend beyond O. The flaps are then transposed as shown in E. An important part of the technic is to avoid tip necrosis by not placing through-and-through sutures at the tips of the flaps. F and G, show the final results.

and use the different skin incisions shown in the diagrams. This allows us to make the best use of the skin elasticity. To be sure of no edge-to-edge strain, as one advances the skin, rows of subcutaneous sutures are laid down, fastening the flap to the underlying tissues and so relieving the tension on the wound edge. (Fig. 4.)

Some had had as many as four unsuccessful attempts. Many were infected; all were contaminated.

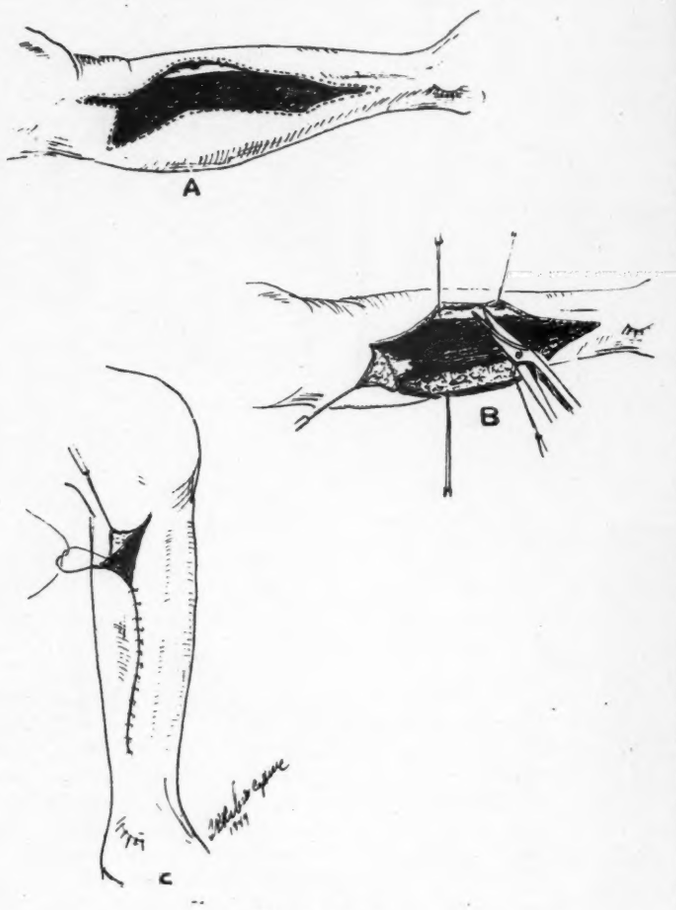

FIG. 13A TO C.

FIG. 13D.

FIG. 13. A TO D, advancement Y closure for extensive irregular wound. Location and direction: Lateral aspect of leg, vertical direction. Size: 18 cm. by 5 cm. Extensive loss of peroneal muscles and associated nerve injury. Tibia incompletely fractured and exposed. A previous simple partial closure resulted in wound breakdown. Marked undermining and closure of wound in a modified Y resulted in an early healed lesion.

SUMMARY OF RESULTS

Fifty selected war wounds of the extremities were closed by the various contiguous skin flap technics. Most of the wounds were old wounds, which had had secondary closures elsewhere with failures.

The wounds of the thigh and buttock presented no problems in closure. Except for superficial suture necrosis and secondary infection the wounds healed readily. The overall picture of the wounds of the upper two-thirds of the leg was good. However, the results of the three cases in the lower one-third of the leg were poor. In two of these cases, there were exposed, infected tendons. Attempted closure by rotation or transposition was followed by necrosis. The skin of the lower one-third

of the leg contains little fatty subcutaneous tissue with resulting impairment of blood supply and poor skin elasticity when the flaps are raised. Transposition of tissue in this region is also inadvisable because of the superficial tendons found laterally, medially and posteriorly and a procedure at this level exposes them.

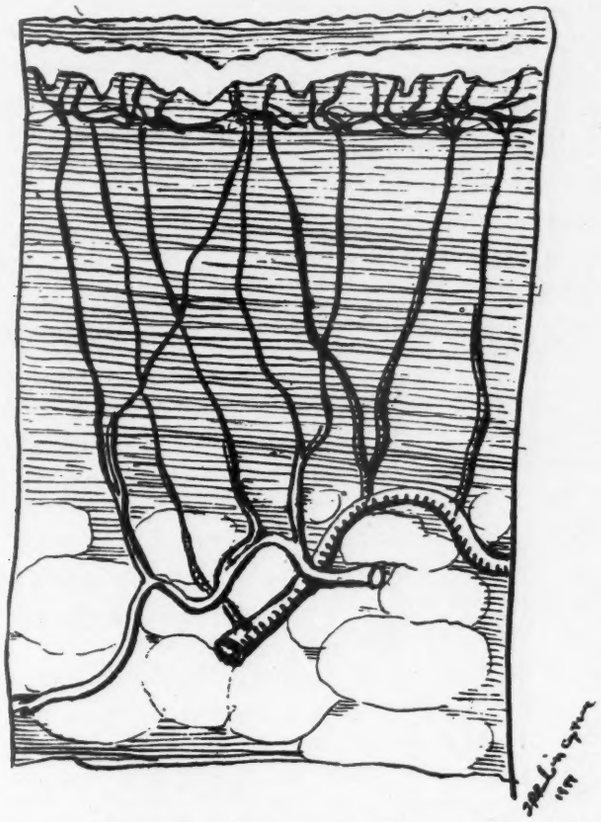

Fig. 14. Illustration of the course of blood vessels in the fat just under the skin. From these larger vessels, capillaries rise in a vertical direction to anastomose just under the stratum germinativum.

The wounds of the arm and forearm were closed without difficulty. Our cases of wounds of the antecubital, groin and popliteal spaces, where "z" plastics were performed, should be critically examined. The patients operated upon presented either open wounds or contracted, broken down, contaminated areas. The "z" plastic was employed to change a straight line to a broken one, thus avoiding a direct line of contracture, as well as to remove the contracted deformity by obtaining an overall increase in length. Since the length increases at the expense of the width, any considerable loss of tissue in the width would prevent the use of the technic. None of our cases were more than 5 cm. wide, either in an open wound or after excision of the cicatrix. To effect closure, it was necessary to do radical undermining of the flaps. At times, about three-quarters of the skin encircling the arm would be raised. This would impair the flap circulation with occasional necrosis of the tips of the flaps despite very careful handling of the skin.

Seven antecubital space wounds closed by the "z" plastic healed well. Those of the popliteal space presented a greater problem. Since the circulation of the lower extremity was not as good as that of the upper, the "z" plastic technic called for two stages. Attempted one-stage closures resulted in discoloration and marked cyanosis of the transposed flaps. The delayed

procedures increased blood circulation. In the five cases of popliteal "z" plastics, it was noted that a one-stage procedure broke down completely, and a split-skin graft had to be applied later. Another one-stage procedure done under a lumbar sympathetic paravertebral block showed distal flap necrosis which was not extensive. This healed under wet dressings. Three cases were of two-stage procedures, of which two had in addition paravertebral blocks. They showed very little flap necrosis.

Two "z" plastics for groin wounds were failures. One broke down upon walking several days after operation. Both grew the usual non-pathogenic cultures. Apparently the resistance of the very thin skin in this area is impaired by extensive undermining. Both of these wounds required split skin grafts for the final closure.

The final results of "z" plastics are good if the cases are properly selected. For any wound of the popliteal or antecubital space which measures over 5 cm. in width, a split skin graft is certainly the procedure of choice. The successful "z" plastic will give a non-adhering, full-thickness and fatty skin cover. Great care, however, is required to obtain the exact size for both skin flaps. Extensive undermining is the keynote. Hooks should be used to avoid trauma to the tissue and fine suture material should be employed.

CONCLUSIONS

1. The contiguous skin flap is a full-thickness skin cover for wounds of the extremities where too much skin has not been lost and where bone, tendon or fascia-less muscles have been exposed.

2. The flaps raised must include all layers of fat down to fascia.

3. Free, extensive undermining is imperative.

4. Stage operations are necessary where the flaps are large or circulation impairment is feared.

5. Sympathetic blocks, nerve block anesthesia and the proper use of heat for the increase of circulation are valuable during the critical postoperative period.

6. The surgical technics are not new but must be exactly understood and followed.

7. The contiguous skin flap is designed primarily for utility and no attempt has been made to obtain a cosmetic result.

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STUDIES ON NEUROMUSCULAR DYSFUNCTION*

NEOSTIGMINE THERAPY OF CHRONIC DISABILITY FOLLOWING FRACTURES REPORT OF FIFTY-ONE CASES

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IT is now generally accepted that neostigmine is the drug of choice in providing relief from fatigue and weakness in the treatment of myasthenia gravis.[1] Neostigmine is believed to act in facilitating transmission of excitation across the myoneural junction by inhibiting cholinesterase and thereby allowing accumulation of acetylcholine at nerve endings.[2]

Recently, significant improvement has been reported from the use of neostigmine in a variety of types of neuromuscular dysfunction. In subacute and chronic poliomyelitis, Kabat and Knapp[3] observed that neostigmine resulted in relaxation of muscle spasm, relief from pain, increase in strength and improvement in muscular coordination. Neostigmine has been shown to be of value in relieving neuromuscular dysfunction in chronic rheumatoid arthritis,[4,5] chronic hemiplegia,[5] chronic facial paralysis,[5] cerebral palsy, [5,6] chronic disability resulting from trauma,[5] cervical intramuscular fibrositis (stiff neck),[7] and acute and chronic backache.[8] Further studies on the clinical use of neostigmine in poliomyelitis have been published.[9–12] Electromyographic studies on patients with poliomyelitis revealed a decrease in irritability of the stretch reflex and a diminution in action potentials associated with muscle spasm following injection of neostigmine.[13] These new developments in the use of neostigmine in the treatment of neuromuscular dysfunction have been reviewed.[14]

In a preliminary report on neostigmine therapy for neuromuscular dysfunction resulting from trauma, Kabat[5] described eight cases of chronic disability following fractures. These patients suffered from persistent joint stiffness, limitation of motion, pain, muscular weakness and fatigue following fractures of various types. The disability had been present for two and one-half months to three years and had not been responding to physical therapy. Seven of these patients showed significant improvement in their disability during one to three weeks of daily injections of neostigmine. In some of these cases, dramatic relief from pain, increase in range of motion and increase in strength were observed within a few days after initiating neostigmine treatment.

These encouraging preliminary results with neostigmine in the treatment of chronic disability following fractures prompted the present study. Fifty-one patients with chronic disability following fractures of various types have been treated with neostigmine and the objective and subjective effects of the drug treatment on the disability have been carefully evaluated. The original preliminary observations have been confirmed; in this series of cases, 76 per cent have shown significant improvement from neostigmine therapy.

MATERIAL AND METHODS

The patients selected for study had been suffering from chronic disability following fractures for a considerable period of time, had not shown spontaneous exacerbations or remissions and were showing little or no progress from routine physical therapy. The disability could in every case be demon-

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strated objectively and muscle spasm or contracture, paresis and pain appeared to play a major rôle. Patients showing evident ankylosis, bony block, non-union, denervation, active inflammation or nervous and emotional disorders were excluded.

Most of the cases were treated as out-patients, a majority having received therapy at the U. S. Public Health Service Dispensary, Washington, D. C. Other cases were treated at U. S. Marine Hospitals in Hudson Street, New York, Stapleton, Staten Island, New York, Norfolk, Virginia and Baltimore, Maryland. Previous therapy had consisted of standard methods of reduction and immobilization of the fracture followed by routine physical therapy.

All observations on these cases were made by the authors. Routinely, the patients were examined at least once a week and careful records were kept of all subjective and objective findings. All examinations on a single case were performed by the same examiner.

Range of passive motion was measured wherever possible by means of a goniometer using uniform bony points as landmarks and was recorded in angles. For the upper extremity, the goniometer was used to measure range of abduction, forward flexion and extension at the shoulder, flexion and extension at the elbow. For the lower extremity, range of passive motion was recorded by means of the goniometer for straight leg raising, hip flexion with the knee flexed, abduction at the hip, flexion and extension at the knee and dorsiflexion and plantar flexion at the ankle. Limitation of range of passive motion in other motions of the extremities were estimated by comparison with the normal extremity and recorded as per cent of limitation of motion. Limitation of flexion of the trunk was measured by having the patient attempt to touch the toes with the knees straight and measuring the distance of the fingertips from the floor. Limitation of passive finger flexion and extension was measured as the distance of the fingernail from the depth of the palm or as the distance of the finger tip from the distal crease of the wrist.

Pain at the point of limitation of passive motion was estimated and recorded as follows: 0, no pain; 1+, slight pain; 2+, moderate pain; 3+ severe pain.

In every patient with a fracture in an extremity, passive range of every motion at every joint in that extremity was tested in the original examination. In subsequent examinations, passive motion was observed only in those motions which had shown limitation of passive range in the original examination. In patients with fracture of the spine, thorough examination of range of passive motion of the lower extremities was carried out.

Strength of voluntary motion was tested for every motion at every joint in the extremity in which a fracture had been sustained. Voluntary muscular power of all motions of the lower extremities was tested in patients with fracture of the spine. The tests of strength for each motion at a joint were carried out in a standardized manner. No attempt was made to isolate individual muscles for testing of strength; the test was for voluntary power of a muscle group in carrying out a particular motion at a joint. In almost all cases, the unfractured contralateral extremity served as a means of comparison and standard of normal strength in facilitating the estimation of strength of muscle groups.

Voluntary power was recorded by a standard numerical system of recording as follows:

0—No contraction.
1—Slight contraction but incapable of producing joint motion against gravity.
2—Voluntary motion against gravity through only part of the total passive range.
3—Voluntary motion through the full passive range against gravity but no motion against any resistance.
4—Voluntary motion through the full passive range against slight resistance.

5—Voluntary motion through the full passive range against moderate resistance.

6—Voluntary motion through the full passive range against strong resistance, but significantly weaker than the same motion of the unaffected opposite extremity.

7—Normal strength, equal to or greater than the same motion in the unaffected opposite extremity.

Most patients with weakness following fracture had voluntary muscular power ranging from 2 to 6 by this method of recording.

Pain in voluntary motion was recorded as: 0, no pain; 1+, slight pain; 2+, moderately severe pain; 3+, severe pain.

In cases in which voluntary muscular contraction was incapable of moving the joint through the full passive range against gravity, the angle of range of active motion was measured by means of a goniometer.

In addition to these tests, a number of other tests were used routinely to describe the disability: (1) Upper extremity, ability to touch the top of the head, back of the neck, opposite shoulder, opposite ear over the head, opposite flank behind, etc. (2) Lower extremity, gait, ability to walk on toes and heels, ability to stand on a chair on one leg, etc.

Each patient was questioned in detail about subjective symptoms, ability to carry out ordinary activities, fatigue, muscle cramps, etc. Definite changes in these findings during and after treatment were carefully evaluated.

During the period of observation and treatment all therapeutic measures, including physical therapy were discontinued. As a control procedure to evaluate the effects of the daily intramuscular injection, twenty of the patients were given daily injections of saline for one week before initiation of neostigmine therapy without being aware that a placebo was being administered.

Neostigmine was administered intramuscularly once daily. The dosage used was neostigmine* methylsulfate, 2 cc. of 1:2000 solution (1 mg.) together with atropine sulfate gr. $\frac{1}{150}$ (0.43 mg.); or neostigmine methylsulfate 3 cc. of 1:2000 solution (1.5 mg.) together with atropine sulfate gr. $\frac{1}{100}$ (0.65 mg.). In the out-patients, injections were administered six times per week, omitting Sunday. The atropine was used to eliminate the unpleasant parasympathetic side-effects of neostigmine. Neostigmine therapy was continued as a rule for two to four weeks. After treatment was discontinued, the patients were followed for as long as possible to determine whether the improvement in the disability was retained.

In our experience, administration of neostigmine for chronic disability following fracture is a safe procedure. Most of the out-patients continued to work throughout the period of neostigmine therapy. Thirty-three of the fifty-one patients were over forty years of age:

Age	No. of Patients
40–49	13
50–59	15
60–69	3
70–	2

Many patients had no reaction at all from the injections. The dosage of atropine had to be adjusted up or down to overcome mild reactions in individual cases. Some patients experienced fascicular twitching, a feeling of thickness of the tongue, slight dizziness and stimulation of intestinal peristalsis. Reactions were minimized by administration of the drugs soon after a meal. As a rule, side-effects were greater at first and decreased after treatment was continued for a few days. In no case were serious reactions observed and treatment did not have to be discontinued in any of these patients because of toxic effects. Since susceptibility to neostigmine and to atropine varies considerably in different individuals, the best procedure is to start

*The neostigmine methylsulfate was furnished through the courtesy of the Hoffman-La Roche Co., Nutley, N. J.

with a small dose of the drugs and build up the dose in the course of a few days to the tolerance of the individual.

RESULTS*

Case Data. The essential data in the fifty-one cases of chronic disability following fractures treated with neostigmine are recorded in Tables I, II and III. Every patient with chronic disability following a fracture who has received a course of neostigmine injections has been included in this series of cases.

Of the total of fifty-one patients, twenty-three had fractures of the upper extremity, seventeen had fractures of the lower extremity, seven had fractures of vertebrae and four had sustained multiple fractures. The ages of these patients varied from seventeen to seventy-two years, with an average age of forty-four years. Most of the patients were males; only seven in the series were females. The duration of the disability ranged from two months to twenty-seven years. Excluding the disabilities which had been present longer than five years, the average duration of the disability was 11.2 months.

Of twenty patients who were given daily injections of saline for one week as a placebo preceding the administration of neostigmine, only two showed any improvement from the placebo, the others showing absolutely no change in the disability from these control injections. The two patients who improved on saline showed slight but not significant improvement.

Neostigmine was usually administered for two to three weeks. This treatment resulted in significant improvement in thirty-nine of the fifty-one cases studied; thus 76 per cent of these patients with chronic disability following fractures obtained significant benefit from neostigmine. Since the cases were all chronic and had not been improving appreciably on physical therapy, these results are definitely significant. Of the remaining twelve cases, four showed definite but slight improvement, which, however, was not significant in relieving the disability, while the other eight cases showed no improvement at all from neostigmine therapy. In patients with fracture of the upper extremity, sixteen out of twenty-three or 70 per cent showed significant improvement from neostigmine therapy. (Table I.) Of seventeen patients with fracture of the lower extremity, fourteen or 82 per cent showed significant improvement from neostigmine. (Table II.) Of seven patients with fracture of vertebrae, six or 85 per cent showed significant improvement and of four patients with multiple fractures, three or 75 per cent showed significant improvement from neostigmine. (Table III.) It is thus evident that a similar proportion of patients suffering from chronic neuromuscular dysfunction following fractures are significantly improved by neostigmine regardless of the location of the fracture.

It has been possible to follow twenty-seven of the thirty-nine patients who showed significant improvement from neostigmine therapy for one to eight months after treatment was discontinued. In all except one of these cases, the improvement was retained after cessation of drug administration.

Representative case reports of patients showing marked improvement^{+++} from neostigmine therapy are presented below. These patients were treated as out-patients and continued to work while under treatment. All other types of treatment for the disability were discontinued during the period that these patients were under observation.

CASE REPORTS

Case 8. This sixty-seven year old woman sustained a comminuted fracture of the distal end of the left radius and ulna in January, 1944. (Table I.) Nine and one-half months later,

* A majority of the cases reported were treated at the U. S. Public Health Service Dispensary, Washington, D. C., Senior Surgeon J. W. Cronin, Medical Officer in Charge. The cooperation and advice of Surgeon W. A. Williamson are gratefully acknowledged.

TABLE I

NEOSTIGMINE THERAPY OF CHRONIC DISABILITY FOLLOWING FRACTURES

FRACTURES OF THE UPPER EXTREMITY

+++ Marked improvement } Significant improvement
++ Moderate improvement }
+ Slight improvement } Not significant
o No improvement }

Case No.	Age	Sex	Diagnosis	Duration of Disability (months)	Improvement on Saline, 1 Week	Period of Neostigmine (weeks)	Improvement on Neostigmine	Improvement in:				Follow-up (months)	Improvement Retained
								Passive Range	Voluntary Power	Pain	Fatigue		
1	47	F	Fracture left radius and ulna, distal third.	5	..	2	+++	++	+++	.....	+++	8	Yes
2	27	M	Comminuted fracture surgical neck right humerus. Fracture acromion process right scapula. Dislocation right shoulder.	6	o	2	+++	+++	++	+++	++	¼	Yes
3	32	M	Fracture internal condyle left humerus. Laceration flexor tendons left forearm.	2	o	2	++	++	++	++	++	4	Yes
4	56	M	Fracture head of right radius	7	o	2	o	o	o	o	o		
5	51	M	Compound fracture right radius and ulna distal end. Compound dislocation right wrist. Laceration flexor tendons right wrist. Osteomyelitis for 2 years.	60	..	4	+++	+++	+++	+++	+++	5	Yes
6	56	F	Fracture right radius and ulna, proximal third.	2	o	2	++	++	++	+++	+++	6	Yes
7	54	M	Fracture of right radius, distal third. Fracture right ulnar styloid. Dislocation right distal radio-ulnar articulation.	3	..	2	+	o	o	++	o	1	Yes
8	67	F	Comminuted fracture left radius and ulna, distal end.	9½	o	3	+++	+++	+++	+++	+++	6	Yes
9	40	M	Fracture right radius and ulna, distal third.	324	..	2	o	o	o	o	o		
10	22	M	Fracture left humerus, distal end.	17	o	2	o	o	o	o	o		
11	41	M	Fracture right 4th metacarpal and distal phalanx of index finger. Dislocation right 5th metacarpal. Laceration of extensor tendons of fingers 3, 4 and 5 and flexor tendon finger 5 in right hand.	17	..	3	+++	+++	+++	+++	+++	3	Yes
12	34	M	Fracture head of right radius.	11	o	2	o	o	o	o	o		
13	36	M	Fracture compound comminuted right humerus, middle third. Fracture right radius and ulna, middle third. (External skeletal fixation still applied to right forearm.)	5	..	3	++	++	++	+++	+++	2	Yes
14	31	M	Chip fracture greater tuberosity right humerus. Dislocation right shoulder, laceration capsular ligaments.	2½	o	2	+++	+++	++	+++	++		
15	53	M	Fracture right clavicle, distal end.	2	o	2	+	++	o	o	o		
16	41	M	Fracture acromion process left scapula.	5		2	+++	.....	+++	+++	+++	1	Yes
17	57	M	Fracture greater tuberosity left humerus.	2½	o	2	o	o	o	o	o		
18	51	M	Fracture right radius, proximal third. Comminuted fracture right ulna, distal third. Dislocation right radius and ulna, proximal end. Osteomyelitis. (Right forearm and wrist in cast.)	10	+	2	++	+	++	++	++	6	Yes
19	33	F	Fracture olecranon process, left ulna.	2½	..	3	+++	+++	+++	+++	+++		
20	65	M	Comminuted fracture, head of right humerus.	6		4	+++	++	+++	+++	+++	5	Yes
21	55	F	Fracture left radius and ulna, distal third.	30	o	3	+++	+++	+	+++	+	5	Yes
22	62	M	Comminuted fracture proximal phalanx left index finger.	3	..	2	++	+	++	++	++		
23	47	M	Chip fracture in left radio-humeral joint.	11	..	2	+++	++	+++	+++	+++	1	Yes

despite continuous treatment, the left arm was seriously disabled and no progress had been observed for several months. There was serious deformity. There was great weakness and fatigue in voluntary motion in pronation, supination and in wrist motions, and she suf-

TABLE II

NEOSTIGMINE THERAPY OF CHRONIC DISABILITY FOLLOWING FRACTURES

FRACTURES OF THE LOWER EXTREMITY

+++ Marked improvement } Significant improvement
++ Moderate improvement }
+ Slight improvement } Not significant
o No improvement }

Case No.	Age	Sex	Diagnosis	Duration of Disability (months)	Improvement on Saline 1 Week	Period of Neostigmine (weeks)	Improvement on Neostigmine	Improvement in:				Follow-up (months)	Improvement Retained
								Passive Range	Voluntary Power	Pain	Fatigue		
24	42	M	Fracture head of left femur.	28	..	2	+++	+	.....	+++			
25	56	M	Fracture neck of left femur.	18	o	2	++	++	++	+++	++	4	Yes
26	46	M	Fracture right and left tibia and fibula, middle third.	10	o	2	o	o	o	o	o		
27	47	M	Comminuted fracture external tuberosity left tibia; comminuted fracture neck left tibia.	14	..	3	+++	+++	+++	+++	+++	7	Yes
28	29	M	Comminuted fracture, lateral aspect head of left tibia.	13	..	2	++	++	.....	.....	++	6	Yes
29	33	M	Fracture left femur, middle third.	20	..	4	+++	++	+++	+++	+++	3	Yes
30	40	M	Fracture neck of right femur. Traumatic arthritis, right hip.	16	..	2	++	+	++	++	+		
31	22	M	Compound fracture left tibia and fibula, lower third. Peroneal paralysis. Osteomyelitis.	9	..	2	+++	+++	+	+++	+++		
32	55	M	Comminuted fracture left os calcis with exostosis.	8	o	2	o	o	o	o	o		
33	17	M	Fracture right femur, middle third. Fracture left patella. Fracture right femur, middle third (second time).	42 36	..	2	++	+	++	++	++	2	Yes
34	54	M	Compound fracture left tibia and fibula, distal end. Dislocation left ankle.	4	..	1	+++	+++	++	+++	++		
35	20	M	Fracture right femur, lower third. Amputation below knee.	4	..	1½	+	++	o				
36	50	M	Fracture right tibia and fibula, distal end.	6	..	3	++	o	++	++	++	2	Yes
37	37	M	Fracture left tibia and fibula, distal end. Paralysis left lower extremity from poliomyelitis.	4 408	..	3	++	+	++	+++	+++	1	Yes
38	34	F	Fracture right tibia and fibula, distal end.	3	..	2	+++	+++	+++	+++	+++	2	Yes
39	59	M	Fracture right femur, lower third. Malunion. Fracture left tibia and fibula, upper third.	24 288	..	3	++	++	+++	+++	++	4	Yes
40	41	M	Fracture left tibia, middle third. (External skeletal fixation still applied.)	4	..	2	+++	+++	.....	+++			

marked limitation of passive motion at the left shoulder, wrist and fingers. (Table IV.) The fingers could be flexed passively to one inch from the palm and there was marked limitation of extension of the fingers, resulting in a fered from pain in ordinary use of the left upper extremity. (Table IV.) The left hand was cold and white as a result of poor circulation.

After one week of saline as a placebo, there was no significant change in the disability.

(Table IV.) After one week of neostigmine therapy, there was a definite and significant increase in range of motion and of voluntary muscular power. (Table IV.) The fingers could be flexed to ¼ inch from the palm, the little finger flexed to touch the palm and range of extension of the fingers was increased significantly. Pain and fatigue were diminished. After three weeks of neostigmine injections, strength was normal in all motions of the left upper extremity and range of passive motion showed marked improvement. (Table IV.) There was marked improvement in flexion and extension of the fingers and in circulation in the left hand. Pain and excessive fatigue in the left upper extremity had entirely disappeared. This patient has been followed for six months after neostigmine was discontinued and the improvement was completely retained. At the last examination, there had been slight further improvement in range of motion at the wrist.

TABLE III

NEOSTIGMINE THERAPY OF CHRONIC DISABILITY FOLLOWING FRACTURES

FRACTURES OF VERTEBRAE AND MULTIPLE FRACTURES

+++ Marked improvement } Significant improvement
++ Moderate improvement }
+ Slight improvement } Not significant
o No improvement }

Case No.	Age	Sex	Diagnosis	Duration of Disability (months)	Improvement Saline 1 Week	Period of Neostigmine (weeks)	Improvement on Neostigmine	Improvement in:				Follow up (months)	Improvement Retained
								Passive Range	Voluntary Power	Pain	Fatigue		
41	30	M	Compression fracture, 2nd lumbar vertebra.	7	..	1½	+++	++	.....	+++	.....	¼	Yes
42	52	M	Compression fracture 12th thoracic, 1st lumbar and 5th lumbar vertebrae. Fracture first right metacarpal. Fracture external condyle right tibia.	7	..	3	++	+	++	++	.....	1	Yes
43	49	F	Fracture of coccyx.	5	..	2	+++	.....	.....	+++	.....	2	Yes
44	45	M	Compression fracture 1st lumbar vertebra. Bilateral fractures of ischium and pubis. Fracture left wing of sacrum. Non-union of pelvic fractures. Distortion of pelvis.	11	+	2	o	o	o	o	o		
45	51	M	Compression fracture 1st lumbar vertebra.	17		5	+++	++	+++	+++	++	3	Yes
46	48	M	Compression fracture 3rd lumbar vertebra. Fracture left transverse processes of lumbar 1, 2, 3 and 4 vertebrae. Fracture right radius and ulna, proximal end. Dislocation right elbow.	12	o	7	++	++	+++	++	++	2	No
47	34	M	Fracture right transverse processes 3rd and 4th lumbar vertebrae.	3	..	2	+++	+++	.....	+++	.....	¼	Yes
48	70	M	Fractures of pelvis; right radius and ulna; right tibia and fibula.	4	o	2	++	++	++	+	++		
49	31	M	Compound comminuted fracture left femur, middle third. Fracture left clavicle and acromion process left scapula.	8	o	3	++	++	+++	++	++	5	Yes
50	72	M	Fracture left femur, tibia and fibula, radius and ulna.	10	o	2	+	+	+	o	o		
51	39	M	Fracture right tibia, upper third. Fracture head of right fibula. Fracture right patella. Fracture left patella. Fracture right radius and ulna, distal third.	30	..	2	+++	o	+++	+++	+++	2	Yes

TABLE IV

EFFECTS OF NEOSTIGMINE ON RANGE OF PASSIVE MOTION AND VOLUNTARY MUSCULAR POWER. CASE 8—COMMINUTED FRACTURE, LEFT RADIUS AND ULNA, DISTAL END. DURATION 9½ MONTHS. FEMALE, AGE 67

(Methods of measurement and recording described in text under "Material and Methods")

Left Upper Extremity	Passive Motion					Voluntary Muscular Power				
			Neostigmine					Neostigmine		
	Before Treatment	Saline, 1 Week	1 Week	2 Weeks	3 Weeks	Before Treatment	Saline, 1 Week	1 Week	2 Weeks	3 Weeks
Shoulder—abduction	95°	90°	105°	120°	135°					
forward flexion	110°	110°	130°	140°	150°					
external rotation	80% L*	80% L	20% L	10% L	10% L					
Elbow—supination	10% L	10% L	0†	0	0	5	5	6	6	7
pronation	.....	.....	.....	.....	.....	5	5	6	7	7
Wrist—flexion	50% L	50% L	50% L	40% L	20% L	6	6	7	7	7
extension	100% L	100% L	80% L	70% L	70% L	4	4	6	6	7
ulnar deviation	90% L	90% L	90% L	50% L	40% L	4	4	5	7	7
radial deviation	90% L	90% L	90% L	90% L	90% L	4	4	7	7	7

* 80% Limitation or 20% of normal range of motion.
† No limitation or normal range of motion.

TABLE V

EFFECTS OF NEOSTIGMINE ON RANGE OF PASSIVE MOTION AND VOLUNTARY MUSCULAR POWER. CASE 27—COMMINUTED FRACTURES EXTERNAL TUBEROSITY LEFT TIBIA AND NECK OF LEFT FIBULA. DURATION 14 MONTHS. MALE AGE 47

(Methods of measurement and recording described in text under "Material and Methods")

Left Lower Extremity	Passive Motion					Voluntary Muscular Power				
	Neostigmine					Neostigmine				
	Before Treatment	1 Day	1 Week	2 Weeks	3 Weeks	Before Treatment	1 Day	1 Week	2 Weeks	3 Weeks
Hip—flexion	.....	.....	.....	.....	.....	5	6	6	7	7
abduction	.....	.....	.....	.....	.....	4	6	7	7	7
adduction	.....	.....	.....	.....	.....	6	7	7	7	7
Knee—flexion	130°	110°	105°	110°	110°	6	7	7	7	7
Ankle—dorsiflexion	110°	106°	102°	100°	100°	5	7	7	7	7
plantar flexion	148°	148°	145°	150°	162°	7	7	7	7	7
inversion	90% L*	50% L	25% L	25% L	10% L	5	7	7	7	7
eversion	90% L	50% L	50% L	50% L	50% L	7	7	7	7	7
Toes—flexion	50% L	25% L	10% L	10% L	10% L	4	5	5	7	7
extension	50% L	25% L	10% L	10% L	10% L	7	7	7	7	7

* 90% Limitation or 10% of normal range of motion.

Case 27. This forty-seven year old man sustained comminuted fractures of the external tuberosity of the left tibia and of the neck of the left fibula into the knee joint in September, 1943. (Table II.) Fourteen months after the injury, despite continuous physical therapy, he complained of serious disability of the left lower extremity and had shown no improvement for months. He suffered from pain in the left knee and ankle and frequent cramps in the thigh muscles. The pain in the ankle was severe enough to awaken him from sleep every night. There was marked limitation of passive motion at the left knee, and ankle (Table V), which seriously interfered with lacing his shoes, driving a car, walking upstairs, etc. He walked with a moderately severe limp. The left lower extremity was weak (Table V) and fatigued very readily.

Following the first injection of neostigmine, the patient noted that he was not awakened by pain in the ankle. There was striking relief from pain and fatigue, which was associated with a definite increase in range of motion and strength. (Table V.) After three weeks of neostigmine therapy, all pain, muscle cramps and excessive fatigue in the left lower extremity had completely disappeared. Voluntary muscular power in all motions of the left lower extremity was restored to normal and there was significant improvement in range of passive motion. (Table V.) The patient walked without a limp and found it easy to lace his shoes, drive a car and walk upstairs. He has been followed for seven months since neostigmine therapy was discontinued and has retained the improvement.

Case 45. This fifty-one year old man sustained a compression fracture of the first lumbar vertebra with marked wedging in May, 1943. (Table III.) He continued to complain of severe disability in spite of treatment and had failed to show significant improvement for many months. Seventeen months after the injury, he complained of severe pain in the back and frequent incapacitating shooting pains from the lumbar region down the lateral aspect of the right leg into the toes. The pain routinely interfered with sleep and caused him to be out of work approximately two days in every six. He complained of marked fatigability, especially of the right lower extremity. There was moderate limitation of motion of the lumbar spine in flexion and lateral motion; in bending forward with the knees straight, the fingertips reached to 14 inches from the floor. There was no limitation of motion in the lower extremities but passive straight leg raising resulted in severe pain in the lumbar region. Because of limitation of motion and pain, he was unable to put on and remove his socks and shoes himself. The stiffness in the back was greater on arising and caused great difficulty in getting out of bed. He had difficulty in squatting and in putting his foot on a chair. The patient was unable to stand on a chair on his right leg and had great difficulty in standing on a chair on the left leg. He was unable to walk on the toes of the right foot. Voluntary muscular power was below normal in motions of both lower extremities. (Table VI.)

A roentgenogram taken seventeen months after the injury revealed deformity of the body of the first lumbar vertebra and union of the bodies of the twelfth thoracic and first lumbar vertebrae by callus. The normal curve of the lumbar spine was absent.

Daily injection of neostigmine methylsulfate 2 cc. of 1:2000 solution with atropine sulfate gr. $\frac{1}{150}$ were administered intramuscularly. After five injections, the patient reported a striking decrease in frequency and severity of the shooting pains and was no longer awakened by pain. There was a definite increase in range of flexion and lateral deviation of the lumbar spine; he was able to bend forward to reach the fingertips to 10 inches from the floor. During the second week of treatment, the shooting pains entirely disappeared and have never recurred.

After five weeks of neostigmine therapy, he had no difficulty in sleeping and had been free from shooting pains. There was moderate improvement in the low back pain and the excessive fatigue. He was now working steadily and rarely lost a day from work because of his disability. There was significant improvement in range of motion of the lumbar spine and passive straight leg raising no longer caused pain in the back. He was putting on and removing his own socks and shoes without difficulty. The stiffness in the back on arising and the difficulty in getting out of bed were no longer evident. He was able to stand on a chair on either leg with ease, had no difficulty in walking on the toes and showed striking improvement in squatting. Voluntary power

had become normal in all motions of the lower extremities. (Table VI.)

The patient was followed for three months after neostigmine therapy was discontinued and fully retained the improvement. He had been entirely free from shooting pains but still had some pain in the lumbar region, worse on some days (particularly rainy days) than others; the back pain was less frequent and less severe than before neostigmine therapy. Three months after treatment was stopped, he was given a second course of daily injections of neostigmine methylsulfate 3 cc. of 1:2000 solution and atropine sulfate gr. 1/100, which caused only insignificant side-effects. This therapy resulted in a further significant decrease in frequency and severity of pain in the lumbar region and improvement in range of motion. He was now able to bend forward to reach the finger tips to eight inches from the floor without pain in the back and range and ease of hip flexion with the knee flexed was increased significantly.

TABLE VI

EFFECTS OF NEOSTIGMINE ON VOLUNTARY MUSCULAR POWER CASE 45—COMPRESSION FRACTURE FIRST LUMBAR VERTEBRA DURATION 17 MONTHS. MALE AGE 51

(Methods of measurement and recording described in text under "Material and Methods")

Right Lower Extremity	Before Treatment	Voluntary Muscular Power					
		Neostigmine					No Therapy
		1 Week	2 Weeks	3 Weeks	4 Weeks	5 Weeks	3 Months
Hip—flexion	5	5	6	7	7	7	7
extension	5	5	6	7	7	7	7
abduction	5	5	6	7	7	7	7
adduction	5	5	6	7	7	7	7
external rotation	5	7	7	7	7	7	7
internal rotation	5	5	7	7	7	7	7
Knee—flexion	5	5	7	7	7	7	7
extension	5	5	6	7	7	7	7
Left Lower Extremity							
Knee—flexion	5	..	7	7	7	7	7
extension	6	..	7	7	7	7	7

Relief of Pain. Neostigmine is known to act by inhibition of cholinesterase, thereby allowing accumulation of acetylcholine at cholinergic nerve endings and at synapses.[2] Evidence has been presented by Slaughter,[15] that neostigmine can potentiate the analgesic effect of morphine, but this potentiation has been questioned.[16] Neostigmine has not been considered an analgesic or a sedative.[2] Yet one of the striking features of neostigmine therapy in patients with chronic disability following fractures has been the rapid relief of pain and the persistence of this pain relief after treatment was discontinued.

A number of types of deep pain have been relieved by neostigmine therapy in this series of patients with chronic disability following fractures:

1. *Pain referred to muscles:*

(a) Muscular pain relieved by neostigmine, associated with increase in range of joint motion.

Case 19. Pain in muscles of the forearm and arm relieved by neostigmine, along with an increase in range of elbow motion of 30

degrees and restoration of full range of motion at the shoulder.

Case. 31. Pain in calf muscles on weight bearing relieved by neostigmine, associated with increase in range of ankle motion of 25 degrees.

(b) Muscular pain relieved by neostigmine without associated increase in range of joint motion.

Case 41. Severe pain in the muscles in the lumbar region disappeared during neostigmine therapy but there was no change in the rigid lordosis of the lumbar spine. (A similar observation has been made in cases of chronic Marie-Strumpell's arthritis with bony ankylosis).

(c) Pain associated with muscle cramps. Painful muscle cramps disappeared during neostigmine therapy and did not recur afterwards in cases 27, 37 and 39.

Case 37. This patient had paralysis of the left lower extremity from poliomyelitis since infancy, with severe atrophy of the calf and thigh muscles. An arthrodesis of the left ankle had been performed many years before. In January, 1945, he fractured the distal end of the left tibia and fibula. Four months later, he complained of severe pain on weight bearing in the region of the left lateral malleolus and frequent painful cramps in the atrophied left posterior calf muscles. On neostigmine therapy, the muscle cramps disappeared and the pain in the region of the ankylosed ankle joint was markedly improved.

(d) Muscular pain on active motion against resistance, or associated with fatigue, without limitation of joint motion, muscle spasm or muscle cramps. This type of pain was relieved by neostigmine in cases 3, 16, 23, 24.

Case 23. Local tenderness of left radiohumeral joint was not affected by neostigmine therapy, whereas the muscular pain on active motion against resistance and the muscular aching associated with fatigue completely disappeared.

(e) Tender painful nodule in muscle disappeared during neostigmine therapy.

Case 21. A firm tender painful nodule about one inch in diameter protruded from the muscles on the ulnar side of the left forearm and had been present since the fracture two and one-half years before. During the course of neostigmine therapy, the pain, tenderness and the nodule itself disappeared and have not recurred. (The same phenomenon has been observed in a case of injury of the shoulder without fracture).

2. *Pain referred to joints:*

(a) Joint pain relieved by neostigmine, associated with increase in range of motion at the joint.

Examples include:

Case 5. Joints of fingers, right hand.

Case 6. Joints of fingers, right hand.

Case 11. Joints of fingers, right hand.

Case 22. Proximal interphalangeal joint, left index finger.

Case 27. Pain in right knee joint and right ankle joint disappeared during neostigmine therapy, associated with increase in range of knee flexion of 20 degrees and marked increase in range of motion at the ankle. (Table v.)

Case 29. Twenty months after fracture of the middle third of the left femur, this patient had considerable pain and slight limitation of motion in the left big toe. He was unable to wear his old shoes and continued to have pain in the big toe with several different types of shoes. Passive flexion or extension of the big toe resulted in severe pain. After two weeks of neostigmine therapy, the pain and limitation of motion in the big toe had disappeared and he was wearing his old shoes without discomfort. He has been followed for three months since therapy was discontinued and there has been no recurrence.

Case 34. Left ankle joint.

Case 38. This woman fractured the distal end of the right tibia and fibula three months previously. There was an equinus deformity of the right foot, associated with pain referred to the ankle joint. Passive dorsiflexion was limited at 145 degrees. After one week of neostigmine therapy, the ankle pain as well as the equinus deformity had disappeared; passive dorsiflexion measured 95 degrees.

Case 39. Right knee joint.

Case 40. Left knee joint.

Case 46. Right elbow joint.

Case 51. Right knee joint.

3. *Miscellaneous types of pain:*

(a) Pain in the region of bony ankylosis of a joint:

Case 5. Severe injury of the right wrist five years previously was complicated by chronic osteomyelitis, which resulted in bony

ankylosis of the right wrist joint. Flexion of the fingers or fatigue of the hand resulted in pain "like a tight band encircling the wrist," in a region of dense scar tissue. This pain disappeared during neostigmine therapy, associated with increased range and ease of motion and increased voluntary power in the fingers.

Case 37. (See 1 (c)). Pain referred to the region of the lateral malleolus of the ankylosed left ankle joint was relieved by neostigmine therapy.

(b) Nerve pain. The severe shooting pains down the lateral aspect of the right lower extremity into the toes in Case 45 disappeared early in the course of neostigmine therapy. (See complete case report.)

(c) Post-concussion headache.[17]

Case 29. At the time of his fracture twenty months previously, this man also suffered an extensive laceration of the scalp over the left eye. This resulted in frequent severe headaches over the left eye, associated with lachrymation, which disappeared during neostigmine therapy and have not recurred.

Cases Which Failed to Show Significant Improvement on Neostigmine Therapy. Of the twelve patients with chronic disability following fractures which failed to improve significantly from neostigmine therapy, four obtained some definite improvement from drug treatment.

Case 7. (Table 1.) On neostigmine, the patient noted disappearance of the sharp pains in the right arm which had previously awakened him from sleep. There was no change in range of motion or strength.

Case 15. (Table 1.) This man showed significant improvement in range of passive motion of the right shoulder from neostigmine, but no change in strength or pain.

Case 35. (Table II.) This man had a severe injury of the right lower extremity with fracture of the lower third of the femur four months before, which had necessitated amputation below the knee. External skeletal fixation had been used for immobilization. A moderate limitation of extension at the knee disappeared during neostigmine therapy but there was no change in knee flexion. This appears to be as much as could be expected in such a case because of the likelihood that scar tissue accounted for the limitation of knee flexion.

Case 50. (Table III.) This patient showed definite improvement in range of flexion of the trunk, flexion of the left hip and radial and ulnar deviation of the left wrist. There was an increase in voluntary power in extension of the left hip and improvement in gait.

Eight patients with chronic disability following fractures showed no change from neostigmine therapy. From an analysis of these cases, it may be possible to obtain a better definition of the type of case which is suitable for neostigmine therapy.

Case 4. (Table 1.) This patient had marked limitation of motion of the right shoulder and right elbow seven months after fracture of the head of the radius, despite previous manipulation under anesthesia.

Case 9. (Table 1.) This man sustained a Colles' fracture twenty-seven years before. He had limitation of extension of the fingers.

Case 10. (Table 1.) This patient sustained a fracture of the distal end of the left humerus into the elbow joint seventeen months before and had limitation of motion in the elbow.

Case 12. (Table 1.) Fracture of the head of the right radius into the elbow joint was sustained eleven months before, and the right arm had been immobilized in a cast for six months. He had limitation of motion at the right elbow and wrist.

Case 17. (Table 1.) Fracture of the greater tuberosity of the left humerus was sustained two and one-half months before. He had marked limitation of motion at the left shoulder and considerable weakness in various voluntary motions of the left upper extremity.

Case 26. (Table II.) Fractures of the middle third of the left and right tibia and fibula were sustained ten months before. The left leg was immobilized in a cast for three and one-half months, the right for five months. He had marked limitation of motion of both ankles without pain.

Case 32. (Table II.) Fracture of the left os calcis was sustained eight months before. The roentgenogram revealed an exostosis. The heel was very painful on weight bearing and the ankle and toes showed marked limitation of motion.

Case 44. (Table III.) This man sustained multiple fractures of the lumbar

vertebrae and pelvis eleven months before. The pelvis was distorted and some of the pelvic fractures had failed to unite. He suffered from limitation of motion and pain in the back and lower extremities.

It will be noted that four of these patients (Cases 4, 10, 12 and 17) had fractures into a joint with limitation of motion at that joint. In such cases, scar tissue in the traumatized joint frequently plays a major rôle in the limitation of motion, which may account for the failure to respond to neostigmine. On the other hand, significant improvement in range of motion from neostigmine therapy has been observed in joints in which a fracture had been sustained (Cases 2, 14, 20, 27, 28, 34 and 38). It appears probable that both muscle spasm and fibrous contracture are factors in the limitation of motion at such a joint and that the relative significance of these two factors varies from case to case. At the present time, there is no technic available to differentiate these factors with certainty in limitation of joint motion in clinical cases.

Another factor which may account for failure to respond to neostigmine was the prolonged immobilization in casts in Cases 12 and 26. One patient (Case 9) had limitation of motion for twenty-seven years and another case (Case 44) was complicated by non-union and distortion of the pelvis. The patient with a painful heel with fracture of the os calcis (Case 32) is of interest since no relief of this pain referred to the bone was observed from administration of neostigmine.

COMMENTS

Neostigmine has definite value in the treatment of chronic disability following fractures. It has resulted in increase in range of passive motion, increase in strength, decrease in fatigue and relief from pain. Improvement occurs rapidly and is retained after therapy is discontinued.

The drug has this therapeutic effect by its action on the neuromuscular mechanism. The increase in range of motion and relief from pain is secondary to the relaxation of muscle spasm and contracture. The increase in strength and diminution of fatigue is the result of facilitation of transmission of nerve impulses. Neostigmine is a specific inhibitor of the enzyme cholinesterase, thereby allowing accumulation of acetylcholine at nerve endings and synapses.[2] Through this mechanism, by its action on the central nervous system, neostigmine inhibits muscle spasm and facilitates voluntary contraction of skeletal muscle.[14] The relative importance of the action of neostigmine at the myoneural junction in therapy for neuromuscular dysfunction following fractures remains to be elucidated.

The striking improvement obtained with neostigmine therapy in this series of cases of chronic disability following fractures demonstrates the important rôle that neuromuscular dysfunction plays in such chronic disabilities. As a result of fracture, trauma to soft tissues, immobilization and disuse, abnormal reflex patterns become established which may continue for a long time after the initiating factors have been eliminated. The neuromuscular dysfunction once established, may itself become the major factor in the disability and remain resistant to therapy. The genesis of and mechanisms involved in neuromuscular dysfunction resulting from trauma provide a fruitful field for investigation.

One of the notable effects of neostigmine in this series of cases has been the relief of pain. Neostigmine has not been considered an analgesic,[2] yet pain referred to joints as well as muscles has disappeared during neostigmine therapy in patients with chronic disability following fractures and the pain did not recur after treatment was stopped. An analysis of this effect indicates that the relief of pain by neostigmine is secondary to the relaxation of muscle spasm by the drug. No relief of pain occurred in a case of pain referred to bone (fracture of the os calcis, Case 32). One patient (Case 45) developed an acute subacromial bursitis while receiving neostigmine therapy and suffered severe pain

in the shoulder; at the same time, pain in the back and shooting pains down the leg were greatly relieved by the neostigmine. One patient in this series (Case 23) with a chip fracture in the left radiohumeral joint had relief from muscular pain but the pain and tenderness localized in the left radiohumeral articulation was uninfluenced by neostigmine therapy. The pain of acute rheumatoid arthritis has not responded to neostigmine.[5] One patient observed recently was relieved of low back pain and muscle spasm but showed no relief from an associated sciatic pain. Neostigmine combined with morphine was not significantly more effective in raising the pain threshold of the skin than morphine alone.[16] These observations indicate that neostigmine is not an analgesic drug. Relief of pain in joints as well as muscles in cases with chronic disability following fractures has usually been accompanied by increase in range of passive motion and relaxation of muscle spasm. It is known that muscle spasm can produce pain[18,19] and neostigmine has been shown to inhibit muscle spasm in poliomyelitis,[3] arthritis,[4,5] acute "stiff neck,"[7] acute and chronic backache[8] and in disability resulting from trauma.[5]

Strength of voluntary motion against resistance has increased rapidly in many cases of chronic disability following fractures during neostigmine therapy. While the relief from pain and increase in range of motion were undoubtedly reflected in increased voluntary power, the increase in strength observed cannot be accounted for solely on this basis. In a number of instances, rapid improvement in strength has been observed in motions at joints which showed no limitation of motion or pain. Of particular interest is the fact that strength of voluntary motion may be rapidly restored to normal during neostigmine therapy in muscles which have undergone obvious atrophy from disuse, in spite of the fact that the atrophy had undergone no evident change during the period of neostigmine administration.

SUMMARY AND CONCLUSIONS

1. Fifty-one cases of chronic disability following various types of fractures of the upper extremity, of the lower extremity, and of the vertebrae have been treated with neostigmine. The average duration of the disability in these cases was over eleven months.

2. Seventy-six per cent of these patients have shown significant improvement in the disability from several weeks of daily injections of neostigmine and atropine. The improvement was uniformly retained after therapy was discontinued.

3. Neostigmine therapy resulted in increase in range of passive joint motion, increase in strength, relief from pain and improvement in fatigue. Pain referred to joints as well as to muscles has been relieved by neostigmine.

4. In twenty cases, daily injections of saline as a placebo for one week failed to produce improvement in the disability.

5. Neostigmine results in improvement in chronic neuromuscular dysfunction following fractures by relaxation of muscle spasm and contracture, thereby increasing range of passive motion and relieving muscular and joint pain; and by facilitating voluntary muscular contraction, thereby increasing strength and diminishing fatigue.

6. The therapeutic value of neostigmine in the treatment of chronic disability following fractures emphasizes the important rôle of neuromuscular dysfunction in these disabilities.

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DIABETIC AMPUTATIONS*

AMPUTATION OF LOWER EXTREMITY IN DIABETICS—ANALYSIS OF 128 CASES

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IN the decade 1934–1943, there were 128 major amputations of the lower extremity for diabetic gangrene at the Israel Zion Hospital, Brooklyn. These included both private and ward cases and were performed by a number of surgeons. All the patients were carefully supervised medically and the metabolic and peripheral vascular status appraised and controlled. Every effort was made to save the extremity in each case; and occasionally amputation may have been delayed, in chronic cases particularly, beyond the optimum time for such procedure. Gangrene resulting from major vascular occlusion by embolus is not included in this study.

MORTALITY

Table 1 gives the distribution of the cases in their various age groups and by years. There were forty-two deaths, a 32.8 per cent hospital mortality. No patient failed to survive the actual anesthesia or operation. It is of interest to note that the mortality in the age groups 40 to 49, 50 to 59, and 60 to 69, was essentially the same in nine, forty, and fifty-five cases, respectively. It is only in the 70 to 79 year decade that there appears to be an appreciable increase in the mortality. A study of the yearly mortality revealed surprising variations, 63 per cent in 1934 (eleven cases), 50 per cent in 1936 (ten cases), 7.6 per cent in 1939 (eleven cases), 11 per cent in 1942 (nine cases), and 45 per cent in 1943 (twenty cases). It is important to bear this observation in mind in evaluating results of special services, anesthetics, medications, or physical therapeutic agents in this condition.

SEX

Sixty-two and five-tenth per cent of the cases were women, 37.5 per cent were men. The age distribution and mortality were essentially the same in both sexes in this series.

TABLE 1

A. YEARLY MORTALITY STATISTICS

Year	Total No. Cases	No. of Deaths	Mortality, Per Cent
1934	11	7	63
1935	9	2	22
1936	10	5	50
1937	21	6	28.5
1938	10	3	30
1939	11	1	7.6
1940	15	5	33
1941	12	3	25
1942	9	1	11
1943	20	9	45

B. MORTALITY IN VARIOUS AGE GROUPS

Age Group	Total No. Cases	No. of Deaths	Mortality Per Cent
40–49	9	3	33
50–59	40	12	30
60–69	55	17	30.9
70–79	22	9	40.9
80–89	2	1	50

DIABETES

Various authors[8] have stated or demonstrated that the underlying pathological condition is arteriosclerosis of the larger and medium vessels, with the main disorder in the media, though also appearing in the intimal layers of the vessels. The process is essentially the same as in non-

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diabetic arteriosclerosis, but the effect of diabetes is to advance the process a decade. In Table II, the duration of the diabetes in ninety-nine cases is given. In sixty-six cases there was known diabetes from five to fifteen years. In only eight cases was the diabetes less than one year in duration. The diabetes was severe and difficult to control in nine patients who recovered. There were two deaths from diabetic coma and ketosis, and one in which there was severe toxemia with high blood sugar. Four other patients who died had severe diabetes which, however, cannot be considered a direct cause of death. Diabetes *per se* was a problem in sixteen instances or 12.5 per cent of the cases and the principal cause of death in 2.3 per cent. Most of the cases were mild diabetics of long standing that responded readily to treatment. This experience is similar to that reported by others.[12]

TABLE II
DURATION OF DIABETES IN YEARS

Age	1 Year or Less	2	3	4	5–10	11–15	15–20	21 or More
40–49	3	..	1	..	1	..	1	
50–59	1	..	1	1	9	15	3	
60–69	3	1	1	3	8	19	9	2
70–79	1	..	..	..	4	8	2	
80–89	..	..	..	..	..	2		
Total No. Cases.....	8	1	3	4	22	44	15	2

BILATERAL AMPUTATIONS

Nine patients had had previous amputation of the other lower extremity from six months to six and one-half years prior to the present operation. Eight were females and one was male. There was one death. Six wounds healed by primary union; one had minimal wound infection and one was grossly infected. This is a result contrary to the ordinary expectation and yet is similar to the relatively good results quoted by others in instances of bilateral amputation.[16]

ASSOCIATED ILLNESS AND EFFECT ON PROGNOSIS

About one-third of the cases had no associated clinical illness. The remainder had hypertension, cardiovascular, cerebral, and generalized arteriosclerosis, nephritis, or previous amputation of the other extremity. The mortality rate of those with advanced cerebral or generalized arteriosclerosis, and nephritis was particularly high. Hypertension *per se* did not contribute to increased mortality.

PRELIMINARY SURGERY AND ITS EFFECT ON MORBIDITY AND MORTALITY

By preliminary surgery is meant incision and drainage or minor amputation performed in the hope of controlling the infection or gangrene. Many cases re-

TABLE III

Preliminary Operation	No. of Cases	Recovered	Mortality	
			Number	Per Cent
Incision and drainage, one or more times.....	19	13	6	31.5
Previous toe amputation ± incision and drainage.....	26	17	9	34.6
No preliminary surgery..	83	56	27	32.5

TABLE IV
RELATIONSHIP OF LENGTH OF PRE-AMPUTATION HOSPITALIZATION TO MORBIDITY AND MORTALITY

Days in Hospital before Amputation	No. of Cases	Mortalities		Post-op. Hospital Days			
				25 Days or Less		More than 25 Days	
		No.	Per Cent	No.	Per Cent	No.	Per Cent
5 or less.....	48	11	22.9	27	56.3	10	20.8
6–10.....	23	9	39.1	11	47.8	3	13.1
11 or more...	57	22	38.5	19	33.5	16	28.0

sponded and are excluded from this study. Those cases which subsequently required major amputation and those amputated without preliminary surgery are shown in Table III.

Preliminary surgery had no apparent effect on the mortality rate. Other authors have advocated preliminary surgery as a step in decreasing mortality.[25]

admission. The time periods were arbitrarily chosen. A further discussion of the mortality factors will be given later.

TYPE OF OPERATIVE PROCEDURE AND STUMP MORBIDITY

Table V presents an analysis of the type of amputation and the fate of the stump.

A. Thigh Amputations. There were

TABLE V

Type of Amputation	Type of Case	No. of Cases	Primary Union		Minimal Infection or Skin Necrosis		Gross Infection or Necrosis		Revision Necessary	
			No.	Per Cent	No.	Per Cent	No.	Per Cent	No.	Per Cent
Closed mid or lower thigh; not drained	Infected	36	18	50	8	22	10	27	1	2.7
	Clean	7	6	85	1	14	0	0	0	0
	Total	43	24	55.8	9	20.9	10	23	1	2.3
Closed mid or lower thigh; drained	Infected	27	2	7	8	29	17	63	3	
	Clean	7	2	28	4	57	1	14		
	Total	34	4	11.7	12	35	18	52.9	3	8
Open thigh	Infected	3	..	....	..	....	3	100		
Leg, closed; not drained	Infected	7	2	....	3	....	2			
	Clean	3	1	....	..	....	2			
	Total	10	3	30	3	30	4	40	2	20
Leg, closed; drained	Infected	6	..	....	1	....	5			
	Clean									
	Total	6	..	....	1	16.6	5	83	1	16.6
Leg, open	Infected	9	..	....	2	....	7	....	6	
	Clean	1	..	....	..	....	1			
	Total	10	..	....	2	20	8	80	6	60

Twenty-two cases, nineteen thigh and three leg cases, were excluded because death occurred before the local condition of the stump could be evaluated.

We realize that these figures are subject to errors of sampling and that the series is relatively small. It is, however, interesting to note the better results in cases amputated within five days after hospital

forty-three circular amputations without drainage. Primary union resulted in twenty-four (55.8 per cent), minimal wound infection or necrosis in nine (20.9 per cent) and gross infection or wound necrosis in

ten (23.2 per cent). Revision was necessary in one case. Of thirty-four circular amputations with drainage, primary union resulted in four (11.7 per cent), minimal infection or flap necrosis in twelve (35.2 per cent), and gross infection or flap necrosis in eighteen (52.9 per cent). Revision was necessary in three cases (8.8 per cent).

The number of leg cases subjected to closed amputation are too few for deductions, but the trend is the same as in the thigh amputations. Primary union and lack of gross infection are more likely in undrained cases. In general, there was a higher tendency to gross infection as compared with thigh amputations. The incidence of amputation revisions is much higher both in clean and infected cases and is particularly noticeable with the open operation. The mortality was slightly higher than in the thigh amputation group, the gross mortality in the thigh amputations being 32.2 per cent (thirty-two cases in ninety-nine amputations) and 34.5 per cent in the leg amputations (ten in twenty-nine cases).

TABLE VI

Time of Operation in Minutes	Spinal Anesthesia (60 mg. procaine)				General (N_2O and Ether)			
	15 or Less	16–30	31–45	46–More	15 or Less	16–30	31–45	46–More
No. of cases	5	33	4	1	7	44	8	9
Pulmonary complications	1	1	...	.....	1	6		
Cardiac	1	2	...	1	1	2	1	
Cerebral	2	....	...	.....	6	....	1	
Coma	....	3	...	.....	2	....	1	
Circulatory collapse	....	....	...	.....	1			
Abdominal distention	....	1	...	.....	....	1	1	
Number and per cent of mortalities	3 60%	8 24%	 0%	1 100%	3 42%	16 36%	2 25%	2 22%

111 cases are in this analysis; seventeen cases are excluded because of lack of data.

B. Leg Amputations. There were ten closed cases without drainage in which there was 30 per cent primary union, 30 per cent minimal infection and 40 per cent gross infection. Revision was necessary in two cases (20 per cent). In six closed cases with drainage, there was gross infection in five (83 per cent) and revision was necessary in one case (16.6 per cent). In the open leg operations, ten cases resulted as follows: minimal infection—healing by granulation fairly clean, two cases, 20 per cent; gross infection or flap necrosis, eight cases or 80 per cent. Revision was necessary in six cases or 60 per cent.

Further detail as to relative results in clean or infected cases are indicated in Table v.

In summary, 55.8 per cent of the undrained thigh cases and 11.7 per cent of those drained resulted in primary union. Gross infection occurred in 23.2 per cent of the undrained cases and in 52.9 per cent of the drained cases. There seems to be little doubt that better results are obtained by omitting drainage of the wound.

Five Gm. of sulfanilamide has been deposited in the depths of the stump in all cases for the past few years. It is our impression that there has not been significant improvement in wound morbidity as a result of this procedure.

ANESTHESIA, LENGTH OF OPERATION AND POSTOPERATIVE COMPLICATION

Every patient survived the immediate operative procedure and anesthesia despite the poor general condition of many.

There were two postoperative pulmonary complications in forty-three spinal anesthetics (4.6 per cent) and seven in seventy general anesthetics (10 per cent). The

other complications noted were probably incidental. Certainly the duration of the operation within the limits studied above was not a factor in the ultimate outcome. The mortality in the group with spinal anesthesia was 27.9 per cent and in the group with general anesthesia was 32.8 per cent.

of complete mental orientation, apathy and anorexia.

Table VII presents the distribution according to this scheme. Thirty-six cases were toxic and had considerable local infection on admission. There were nineteen deaths, 52 per cent mortality. Thirty-six cases had gross infection, but no clinical

TABLE VII

MORTALITY RATE AND RELATIONSHIP TO TOXEMIA

General Status of Patient	No.	Toxic on Admission			Developed Toxic State under Treatment			Total No. Died	Mortality Per Cent
		No.	No.	Died, Per Cent	No.	No. Died	Per Cent		
1. Toxic Cases									
A. Mixed Cases—circulatory impairment and infection	64	32	17	53	31	15	48	32	50
B. Infection—No significant circulatory impairment	9	4	2	50	5	2	40	4	44
C. Occlusive gangrene—no infection	3	1	1	100	2	2	100	3	100
Total	76	..	..	...	..	..	...	39	51
1. Non-toxic Cases									
A. Mixed Cases	31	..	..	...	..	...	...	2	5.8
B. Infection—no significant circulatory impairment	3	..	..	...	..	..	...	0	0
C. Occlusive gangrene—no infection	18	..	..	...	..	..	...	1	5.5
Total	52	..	..	...	..	..	...	3	5.9

FACTORS INFLUENCING MORTALITY

Age, sex, yearly mortality incidence, effect of diabetes, type of operations performed and relationship of anesthesia and duration of the operation were mentioned above. The patients are now grouped according to their general condition prior to operation and the type of local lesion. They are divided into those with gangrene due to inadequate circulation, infectious gangrene with adequate circulation, and mixed cases, that is, circulatory impairment and superimposed infection. The presence or absence of toxicity is noted, whether present on admission or developing while under treatment. "Toxic" is used in a general clinical sense to describe a state characterized by dehydration, lack

toxemia on admission. These developed toxemia while under treatment. Seventeen died, 47 per cent mortality. Thirty-four cases with gross infection were not toxic at any time. Two died, 5.8 per cent mortality. In eighteen cases of circulatory gangrene with no infection or toxemia there was one death, 5.5 per cent mortality. There were three other mortalities. These were in cases of occlusive gangrene without infection; one was toxic on admission and two developed delayed toxemia

Summarizing the entire group, ninety-five cases presented both infection and evidence of circulatory impairment, twenty-one had advanced circulatory impairment with no infection, and twelve had infectious gangrene but adequate circulation. Thirty-nine of seventy-six patients who were

toxic died; 51 per cent mortality. Of fifty-two patients who were not toxic, three died, 5.9 per cent mortality.

The specific principal causes of death in the forty-two cases were the following: (1) Chronic toxemia from infected gangrenous extremity or subsequent stump infection, eleven cases. In addition, the following complications occurred in this group: two had parotitis and decubitus, one myocardial failure, one uremia and psychosis, one bronchopneumonia and one cerebral accident. (2) Anaerobic infection, seven cases, 63.6 per cent of all anaerobic infections; (3) acute myocardial failure, coronary sclerosis or thrombosis, six cases; (4) acute postoperative toxemia and hyperthermia, five cases; (5) pulmonary complications, five cases; (6) cerebral accident, three cases; (7) nephritis, two cases, and (8) diabetes, three cases.

Improved end results will follow only when toxemia can be effectively controlled. The main cause of toxemia is infection. It must be remembered, however, that there will always be some deaths because of advanced degenerative disease so common in these patients. The deaths from coronary thrombosis, cerebral vascular accident, and nephritis comprising eleven cases in this series fall in this group. The problem of pulmonary embolism and postoperative bronchopneumonia (five cases) is the same as in all operative problems involving the aged. Better control of infection in the local area may be a factor in decreasing pulmonary complications. However, it is probable that some incidence of pulmonary complication will persist. The same may be said for the occasional severe uncontrollable diabetic.

If mortality will be reduced, we believe that the cases that will respond are those in groups 1, 2, and 4. These comprised eleven deaths from pyogenic infection, seven due to anaerobic infection and five due to a severe postoperative toxemia with hyperthermia, probably with infection as the basis of reaction.

In recent years the sulfonamides were used freely in these infected cases with indifferent results. The advent of penicillin will probably permit the control of toxemia by reducing or controlling simple pyogenic and anaerobic infection in these seriously sick patients.

Eight major amputations for diabetic gangrene were performed from January to September, 1944. Five patients were sixty to sixty-nine years old and three were from seventy to seventy-five years old. Three patients were toxic and five were not. Six had lower thigh and two upper leg amputations. Penicillin was used in five cases. Three healed *per primum*, two had minimal infection and three gross infection. All the patients recovered.

SUMMARY AND CONCLUSIONS

1. One-hundred-twenty-eight cases of diabetic gangrene requiring major amputation are presented.

2. The mortality rate in non-toxic cases (fifty-two) was 5.9 per cent for toxic cases (seventy-six) 51 per cent a total mortality of 32.8 per cent.

3. The most important single factor influencing toxicity was infection.

4. Adequate control of infection, either by chemotherapy or by earlier amputation, will lower mortality.

5. Drainage of amputation wounds increases the incidence of wound infection and prolongs morbidity.

6. In this series, those patients with thigh amputations had less wound morbidity than those with leg amputations. Since many of these patients will never wear a prosthesis effectively, efforts to salvage a better stump by amputation below the knee court unnecessary risks and are usually of no avail.

7. Major amputation is a relatively safe procedure under spinal or general anesthesia. Actual operating time, within reasonable limits, is not a contributing factor to mortality.

8. The diabetes in the majority of cases is readily controlled.

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A TOWEL FOR USE IN THIGH AMPUTATIONS

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A SIMPLE, inexpensive, efficient towel to drape the thigh during amputations is described here. Its value, particularly as a retractor, has been satisfactorily demonstrated on a number of patients at the Cook County Hospital where thigh amputations are frequently performed.

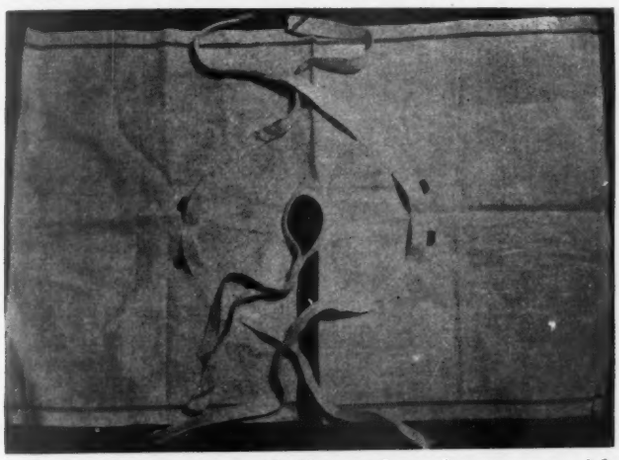

FIG. 1. Towel is cut one-half way through at center with circle about 1 inch in diameter cut out of center; strips are sewed as indicated.

FIG. 2. After the muscle has been separated by the surgeon, and the bone is ready to be sawed through, the towel is applied by placing it around the bone and tying center ties of towel so that the knot is on the side of the cut muscle.

FIG. 3. The towel is then folded over the proximal stump and the other two ties are made.

Material. The material necessary consists of an ordinary 26 inch by 18 inch

towel as used in surgical procedures, and three triple thickness strips of toweling ½ inch by 24 inches. The towel is cut one-half way through at center, with a circle about 1 inch in diameter cut out of the center; the edges are folded to form a seam about ½ inch wide. One of the ½ inch by 24 inch strips is sewed to the toweling around the center opening. The other two strips are sewed to the towel around a circle of about 11 inches in diameter and so placed that finger open-

FIG. 4.

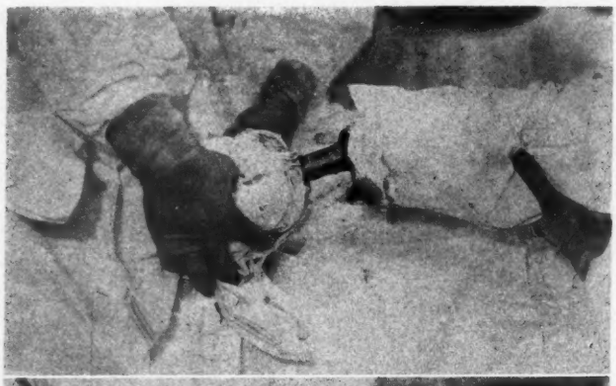

FIG. 5.

FIG. 6.

FIG. 4. This will shape the towel to the proximal stump. An assistant can now retract the muscle by placing his fingers through the finger openings of the towel as indicated.

FIG. 5. The surgeon may now saw the bone without interference from protruding muscle, instruments or assistant's hands.

FIG. 6. After the bone has been sawed, the towel is removed by simply lifting it off the stump.

ings are present between the strips and the towel itself as seen in Figure 1. This completes the towel.

Application of Towel for Amputation. After the muscle has been separated by the surgeon, and the bone is ready to be sawed through, the towel is applied by placing it around the bone and tying the center ties of towel so that the knot is on the side of the cut muscle.

The towel is then folded over the proximal stump and the other two ties are made. This will shape the towel to the proximal stump.

An assistant can now retract the muscle by placing his fingers through the finger openings of the towel as indicated in Fig. 4. The surgeon may now saw the bone without interference from the protruding muscle, instruments or assistant's hands. After the bone has been sawed, the towel is removed by simply lifting it off the stump.

DÉBRIDEMENT is the very antithesis of primary wound excision. Wound excision is a meticulous process, often time-consuming, and only to be carried out soon after wounding. Débridement simply implies enlargement of the wound in order to effect free drainage combined with rapid removal of foreign bodies and obviously dead tissue.

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TREATMENT OF FINGER FRACTURES, SIMPLE AND COMPOUND*

FINGER AMPUTATIONS

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INJURIES involving the fingers, with or without fractures, are very common. This is particularly true in industrial communities where obviously a large portion of the working population is associated with various types of factory work, involving the use of hands in the many machine operations. The fingers represent an exposed portion of the hand, subjected to the many necessary trauma hazards which may be minor or major in character. Industrial full time surgeons of the several large automobile factories located in Flint, Michigan, agree as to the frequency of such accidents. It has been the writer's privilege to see many of the severe finger fractures and their resultant disabilities, in a consulting capacity, occurring in these plants. Much of the discussion in this presentation evolves from this direct association with the problem industrially, as well as from the clinical material presented in a large fracture service at Hurley Hospital, Flint, Michigan, over the past twenty years. The importance of this type of injury is stressed in all of the standard monographs on fracture management by such prominent authors as Kellogg Speed, Wilson and Cochrane, Paul Magnuson, Key and Connell, Watson Jones, etc. The subject is given prominence in the excellent volume "Surgical Anatomy" by J. Latimar Collander.

Fractures of the fingers may be simple or compound, single or multiple, complete or incomplete, transverse, oblique, with all degrees of comminution. They may involve joints, show minimal or marked displacement, and be associated with all degrees of soft tissue injuries.

The etiology, for the most part, is the compression type of injury. Less frequently are the workman's finger ends actively or passively projected against the injuring mechanism. Finger fractures are basically the same as fractures of other long bones. The anatomy varies only in that the epiphysis is at the proximal end. The cortex, medullary canal, and cancellous portions are identical. Osteogenesis is the same. The functions of neighboring joints are just as important. Physiotherapy measures have the same indications. Stiffened joints produce restricted or complete disability. Secondary localized osteomyelitis and necrosis may occur. Delayed and nonunion may be present.

Management is commonly neglected or inadequately done by those of the medical profession who are not fracture minded. Experienced industrial surgeons who are constantly associated with these injuries, and who recognize the importance of a satisfactory result, are most careful and painstaking in their care. Thus, for the most part, the results are very satisfactory. Surgeons of trauma who obviously have many fractures problems are well aware of the importance of good results. The importance of *x*-ray examination in all suspected fractures, and before and following reduction, is emphasized.

Distal Phalanx. This is the most frequent site of finger fractures. These frequently involve the tips and are of the

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squashing comminuted type. Most times there is no significant displacement, and management is by use of a straight splint in a position of extension, until there is satisfactory clinical and radiographic union. There are no rules in fracture healing time, but an arbitrary period of about three weeks is sufficient, followed by physiotherapy if necessary. This is not solid union and, of course, progresses for months. Flouroscopic observation, during manipulation and reduction, is most helpful although not necessary. If there has been an evulsion of the extensor communis digatorum tendon at the base, a drop finger results and immobilization should be secured in hyperextension to fulfill two requirements: healing at the tendon attachment, and healing of the fracture. If the fracture is beyond the attachment of the flexor profundus tendon, the proximal fragment is pulled down and immobilization following reduction in flexion is indicated. If the fracture extends into the joint, immobilize in extension using a straight splint. Joint motion is urged as soon as satisfactory beginning union occurs. The hazard of disturbed joint function is obvious.

Middle Phalanx. The flexor digitorum sublimus muscle ends in a tendon which is divided into two parts, inserted one on each side of the mid portion of the phalanx. The resultant deformity will depend upon the location of the fracture. If the site is distal to the tendon insertion, there is a flexion of the proximal segment, and a dorsal displacement of the distal segment. Alignment is secured by curving the digit over a roller bandage or Davis ball. When the fracture site is proximal to insertion of the tendon, there is a flexion deformity of the distal segment with the proximal portion remaining in an extended position. Immobilization in a straight splint is thus obvious, following alignment of the distal part with the proximal. Failure to observe the principles involved in these two types fails to correct the deformity. Spine formation may develop and interfere with flexion of the distal phalanx. Three weeks immobilization is usually sufficient for beginning union. Physiotherapy follows, directed toward restoration of neighboring joint function.

Proximal Phalanx. The deformity occurring in fractures of the proximal phalanx is quite constant regardless of the site of the fracture. This consists of a palmar angulation of the fracture site due to pull of the interosseous and lumbrical muscles on the proximal fragment, and a dorsal displacement of the distal segment. Here again the displaced fragment must be brought into line with the proximal one and secured in a flexed position, either by use of a curved splint Davis ball or a roller bandage. Continuous traction can be accomplished in this position by use of narrow adhesive tape strips along the lateral surface of the digit, attached to the surface of the ball or bandage, or extended upward and attached to the flexor surface of the wrist. With several proximal phalangeal fractures and malignant overriding, continuous traction is indicated, employing the use of the "banjo splint," transfixed in a plaster of Paris wrist bandage at the base of the wire loop.

Thumb. The thumb is a most important unit in hand function because of its association with grasp and pick up, and obviously satisfactory union of its fractures must occur. Fractures of the phalanges are managed in the same manner as the fingers. The first metacarpal is an important part of this digit. It is in reality a proximal phalanx. Its epiphysis is proximal as are the epiphyses of the phalanges. Fracture dislocations are perhaps the most common type of injury. Faulty union will produce an atrophy of the muscles of the thenar eminence and there will be a weakness of grip. The extra articular fractures may be simple or compound, transverse, oblique, and longitudinal with comminution. Simple fractures predominate. In all of these the fixation should maintain a position of extreme abduction and may be retained thus by the use of plaster of Paris

applied as a spica. In the event of marked upward dislocation of the shaft, as occurs in a Bennett's fracture, there must be an overcoming of the displacement and longitudinal traction is therefore indicated.

Fractures of all phalanges with severe evulsion and non-reducible fragments by normal manipulation and traction procedures require open reduction. The fixation agents are optional, governed by the discretion of the surgeon. In compound fractures, care of the wound is of prime importance. If seen early, closure without tension is indicated. If seen late, leave open and pack lightly with vaseline gauze. The bone should be covered. Associated tendon injuries are obviously repaired. Osteogenesis will be slower in compound fractures, and secondary complications of osteomyelitis and necrosis occasionally occur with residual disabilities more frequent. Local and general chemotherapy both prophylactically and therapeutically are indicated in the selected case.

Padded tongue blades, wooden applicator adhesive splints, direct skeletal traction, by wires through the finger tips and supplemental wire loop attachment to a plaster of Paris wrist forearm bandage, fixed transfixion pins employing the adjacent digits and plaster of Paris encasement, specialized traction and curved adjustable metal finger splints, etc., are contained in the bag of fracture tricks to be used by the surgeon who cares for these injuries.

It is to be noted that the underlying principle in all finger fractures of matching the mobile distal segment to the less mobile proximal one is plain. This would seem to simplify the given essentials of management and relieve the surgeon of remembering mechanical details from various deformities. In the various types of immobilization attention should be constantly kept in mind concerning disturbance of circulation by a constricting portion of the apparatus. Frequent observations during the process of healing and restoration of neighboring joint function should be made until the maximum of use has been obtained. It is only by this chronic enthusiasm that some of the badly mangled fingers can be restored to a degree of function that may be satisfactory to the individual in pursuit of his occupation.

AMPUTATIONS

The common causes for finger amputations are trauma, deformity, or infection. If after painstaking management of a badly damaged finger, there is a resultant disability which renders the digit useless and inhibits maximum function of the remaining fingers and hand, amputation is to be considered. In severe, freshly traumatized fingers the surgeon's obligation is to save as much as possible. The reparative processes are great. If the soft parts are destroyed, it is evident that amputation is indicated. Continuous pain from permanently damaged nerves, complete tendon loss, and joint fixation with deformity are among the indications. Complete agreement between the surgeon and patient is demanded. The question of the patient's desire for amputation on the basis of obtaining financial reimbursement must ever be borne in mind, but in the vast majority of cases, election of amputation will be based upon a disability evaluation that is honest.

If the disability involves the index finger and is complete, with involvement of all joints, amputation is best done in the mid metacarpal area. This insures a better muscle pad and cosmetic result. The second finger then assumes the functions of the first. If the little finger is likewise involved, the same procedure is indicated for the same reasons. If the middle and third fingers are involved, amputations are advised in preference to disarticulations. Disarticulations give unsatisfactory results anywhere. There is almost always a returning function of the metacarpal phalangeal joints and they should never be sacrificed. A short finger stump maintains the knuckle line, aids grip, and prevents

the V-deviation of the adjacent fingers. These principles are likewise true with the thumb. Grasp is the most important function of the hand, with pick up in second place. If the injuries are massive and involve all fingers, maintenance of parts of these functions is definitely indicated. *Save as much as possible.* Long plamar and short dorsal flaps are preferable.

SUMMARY

An attempt has been made to cover the essential principles of the assigned subject. Cases are obviously individualized and management must be conservative and concentrated. By attention to the essential details of this problem, many subsequent plastic and reconstruction operations are eliminated.

Case Reports

POSTOPERATIVE HERNIA FOLLOWING ABDOMINAL PERINEAL RESECTION

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PEORIA, ILLINOIS

AN attempt to review the literature reveals only one reference to postoperative perineal hernia following abdominal perineal resection for carcinoma of the rectum. The Cumulative Index refers only to Yeomans' article in Transactions of the American Proctologic Society, 1937, in which he reports a case of postoperative hernia in a female patient. The discussion by McKenney following this report refers to two cases of perineal hernia following abdominal perineal resections, both of which were in females. All of the above three female patients had had abdominal surgery of the reproductive organs years previously. The first one had been operated thirty-five years previously. The second one had had two laparotomies twenty-five years previously and a hysterectomy twelve years prior to the resection. The third patient had a hysterectomy twelve years before the resection.

Hayden reports two cases both in male patients: one, a large hernia, the contents of which could not be reduced; the other, a small reducible hernia. An attempt was made to give these patients some external support. He reports neither a very great success. Dr. D. F. Jones, of Boston, with over 800 resections, has not seen a single case of hernia. The above reports were taken from the Transactions of the American Proctologic Society, 1937. Dr. Dixon, of the Mayo Clinic, told me in March, 1944, that he had seen two postoperative hernias and operated upon both with immediate results good. Dr. Bacon told me he has just recently seen two in patients of his, but not following abdominal perineal resections.

CASE REPORT

In view of the few cases reported in the literature, I wish to present a case of postoperative perineal hernia which to me has been most interesting from many angles.

The patient was referred to me by a practical nurse, a friend of his wife. He had been seeing his family doctor every week for six months, at which times he would have his abdomen palpated and receive another handful of pills. He had never had a rectal examination. He was first examined by me on July 6, 1943.

Physical examination revealed a white male, fifty-four years old, born in Czechoslovakia, and employed as a common laborer in a steel factory. Examination revealed head and neck normal. Lungs revealed good expansion, normal resonance, normal breath sounds, no râles. Heart examination revealed apex one finger inside mid-clavicular line; cardiac sounds regular, weak and slow, not exceeding 60. Slight systolic murmur at the apex, and blood pressure 125/70. The abdomen was soft with no distention. No tumor masses were palpable; there was no tenderness or rigidity. There were no inguinal glands, and liver, spleen and kidneys were not palpable. Rectal examination revealed numerous skin tags and loss of perianal fat. Digital examination revealed the prostate slightly enlarged and of normal consistency. Above the prostate was a hard indurated area on the anterior wall with elevated edges, movable and apparently not attached. Anoscopic revealed bloody mucus filling scope and large primary and secondary

hemorrhoids. The lower margin of the mass could be seen and appeared to be a cauliflower-like growth. Proctoscopic revealed the mass

Fig. 1. *X*-ray of colon showing large deformity and filling defect of rectum.

about 6 cm. in diameter with ulcerated center on the anterior wall of the rectum. Sigmoidoscope passed full length under direct vision revealed no abnormalities above the rectum.

His chief complaint was of twelve to fifteen stools during a twenty-four-hour period, nocturia, and the loss of thirteen pounds during the past six months. His bowels had always been regular until December, 1942, when he first noticed an increase in the number of stools per day with definite changes in characteristic, these frequent stools being thin and watery and always containing blood, both dark red and bright. He also noticed cramps in the lower abdomen before stools with relief following defecation. His past history was normal except for a right inguinal hernia repaired in 1938. The family history was non-contributory.

The patient entered the hospital on July 7, 1943, where a barium enema was given and *x*-ray of the colon revealed a large deformity and filling defect of the rectum, possibly carcinoma. (Fig. 1.) Otherwise, the colon appeared normal. The blood count was as follows: Hemoglobin 65; red blood cells 3,300,000; white blood cells 6,700. Differential leucocyte count showed segmented cells 65, young cells 2, lymphocytes 30, and monocytes 3. Urinalysis showed specific gravity 1,018 with many pus cells and a trace of albumin. He was hospitalized for six days to prepare for surgery. Preparation included high-caloric, low-residue diet; morning saline

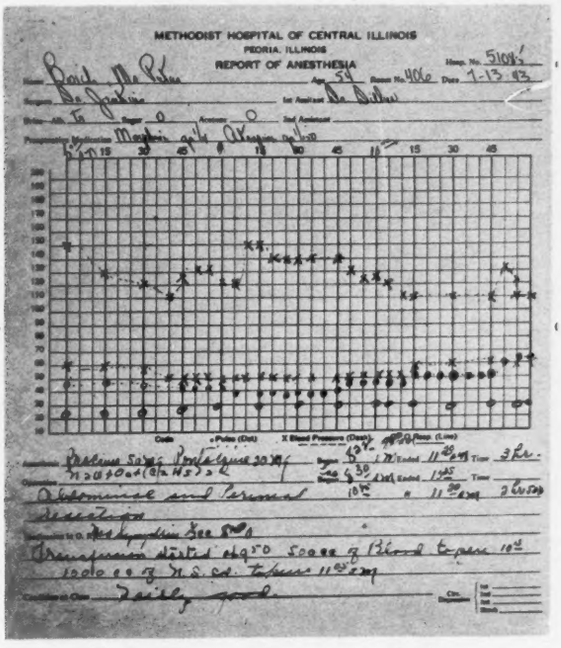

Fig. 2. Report of nurse anesthetist.

laxative daily; evening enema daily; no sulfa drugs administered by mouth. On July 11th, he was given 500 cc. of citrated blood. His pulse rate during this hospital stay varied from 40 to 60. Blood chemistry, such as is routinely done, including serum protein (a–g ratio), serum bilirubin and serum prothrombin, were omitted since the hospital at this time was without the services of a chemist.

On July 13, 1943, abdominal perineal resection was done in one stage and a retention catheter left in the bladder. At the patient's request, spinal anesthesia was used, 50 mg. of procaine in 0.5 cc. spinal fluid followed by 50 mg. pontocaine in 2 cc. 10 per cent glucose. A left paramedian incision was made to above the umbilicus. Liver and gallbladder were normal and no glands were palpable along the aorta or in the iliac region. There was no evidence of peritoneal involvement. The growth was below the peritoneal reflection and mobile. The superior hemorrhoidal vessels were ligated and dissection was made posteriorly down to the sacrococcygeal articulation. The anterior dissection was very difficult as the bladder was firmly attached to the growth. In attempting to separate the bladder from the rectum, a small perforation occurred just above the prostate with the escape of some gas. A purse-

string suture closed this perforation and the dissection was stopped. The lateral ligaments on each side were ligated lateral to two small

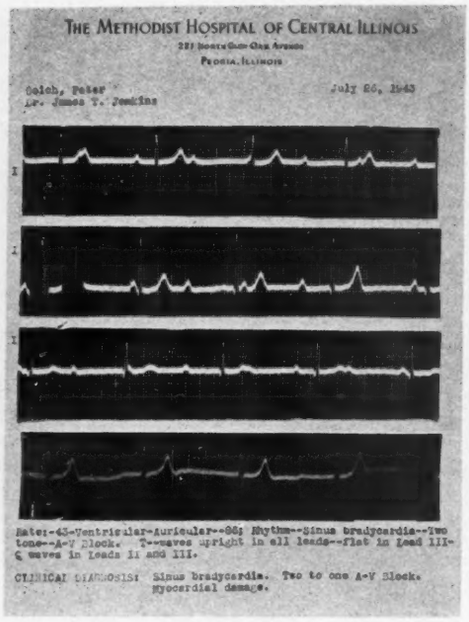
THE METHODIST HOSPITAL OF CENTRAL ILLINOIS
PEORIA, ILLINOIS
Dr. James T. Jenkins
Rate--43--Ventricular-Auricular--86; Rhythm--Sinus bradycardia--Two tone--A-V Block. T--waves upright in all leads--flat in Lead III--Q waves in Leads II and III.
CLINICAL DIAGNOSIS: Sinus bradycardia. Two to one A-V Block. Myocardial damage.

FIG. 3. Electrocardiogram made on the sixteenth postoperative day showing heart block and myocardial damage.

(pea size) glands and cut. De Martel clamp was applied to the sigmoid, the bowel was separated with cautery, and the distal loop dropped in the hollow of the sacrum. The peritoneal reflections were easily approximated and closed with continuous chromic catgut sutures, rebuilding the pelvic floor without tension. The umbilicus was excised and the proximal loop brought out in this area. Peritoneum and fascia were closed with interrupted steel alloy wire sutures, sulfathiazole powder was distributed subcutaneously, and the skin was closed with skin clips. The wound was dressed with Elastoplast bandage.

At this point, the patient complained of discomfort, and cyclopropane was administered. He was turned on his abdomen and the anus was closed with purse-string sutures and posterior dissection was carried out. The coccyx was excised, fascia propria opened, and the clamp and distal loop were delivered posteriorly. The dissection of the bladder and prostate was continued, and with considerable difficulty; the removal was completed without further perforation. Five Gm. of sulfathiazole powder were distributed in the area and a rubber tissue sheet was placed in the posterior cavity, which was packed with gauze. During this procedure, the patient received 500 cc. citrated blood followed by 1,000 cc. of 5 per cent glucose in saline.

The pulse rate during surgery varied between 40 and 70, never getting above 70. (Fig. 2.) The total time of operation was two hours and fifty minutes, which is too long. Loss of time was due to inexperience of student nurses and doctors, time loss in turning and preparing patient for posterior resection, adherence of bladder to tumor mass, perforation, etc. The heart block and myocardial damage in this patient were not felt to be a contraindication for surgery, as the carcinoma was surely to be the cause of his death if not operated upon.

Anatomical diagnosis was found to be papillary adenocarcinoma of the rectum with metastasis to local perirectal lymph nodes. Histology revealed the "A" section showing a malignant epithelial growth such as is usually observed in the rectum. At one point it had completely penetrated the wall and had infiltrated for a short distance into the attached fat tissue. The epithelium differentiated into irregular acinar formations whose cells were the tall columnar variety. Most of the cells had an acidophilic cytoplasm and a few had differentiated into goblet cells. About two cells per high power field were in mitosis. In the "B" section there was a penetration of all layers of the bowel wall. The "C" preparation through the lymph nodes showed hyperplastic lymphoid tissue and in one place there was an infiltration by tumor of the variety seen in the primary mass. The "D" lymph node showed only hyperplastic lymphoid tissue. The "E" section was also from hyperplastic lymph node and showed no evidence of tumor.

Postoperative reaction was uneventful on the first postoperative day, when he was given 500 cc. citrated blood as well as 2,000 cc. of 5 per cent glucose in saline. The clamp was removed from the stoma forty-eight hours postoperatively, and at seventy-two hours, the patient had a bowel movement via the colostomy. On the fourth postoperative day, half of the posterior cavity packing was removed, with complete removal on the fifth day. The wound was clean, there was some sloughing of tissue, the cavity was irrigated daily with potassium permanganate solution, and treated with sulfathiazole powder applied by means of a powder blower. The retention

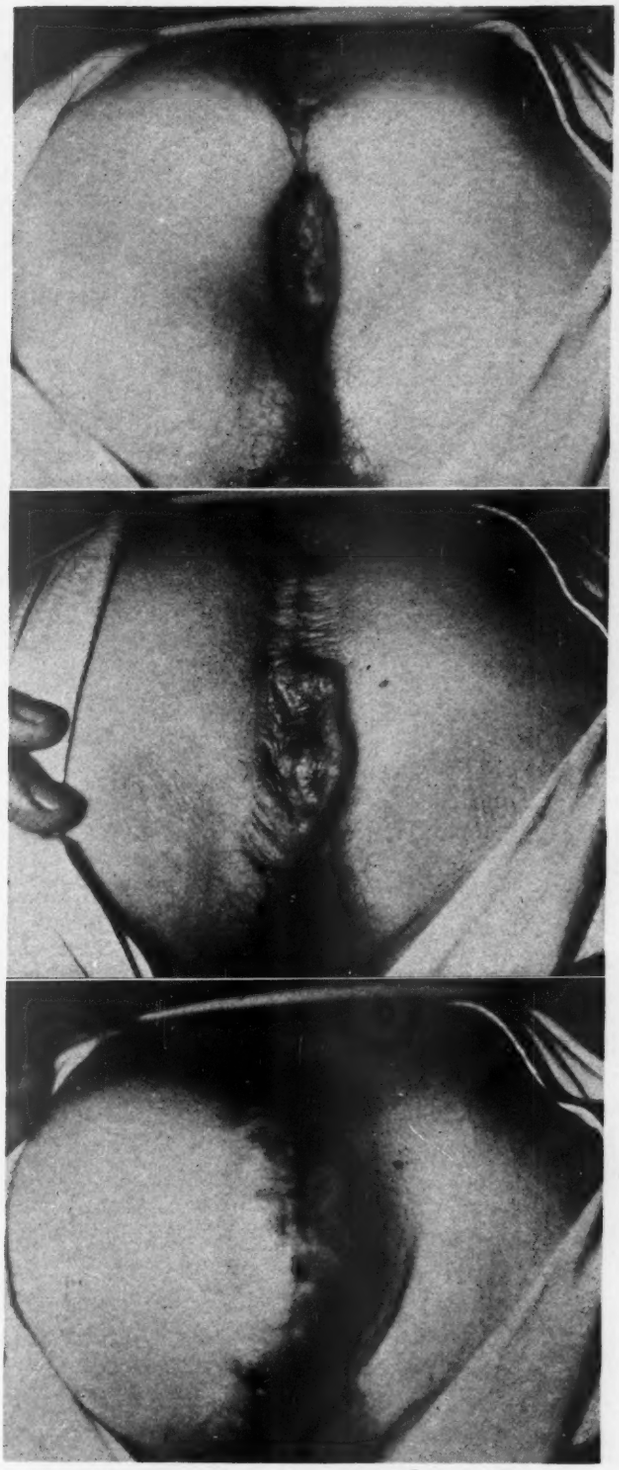

Fig. 4.

Fig. 5.

Fig. 6.

Figs. 4, 5 and 6. Three views of the hernia taken with patient in knee chest position showing hernia reduced, partly reduced, and completely protruded.

catheter was removed on the sixth postoperative day and the patient voided thereafter. The following day he was catheterized for retention and 60 cc. of urine were obtained.

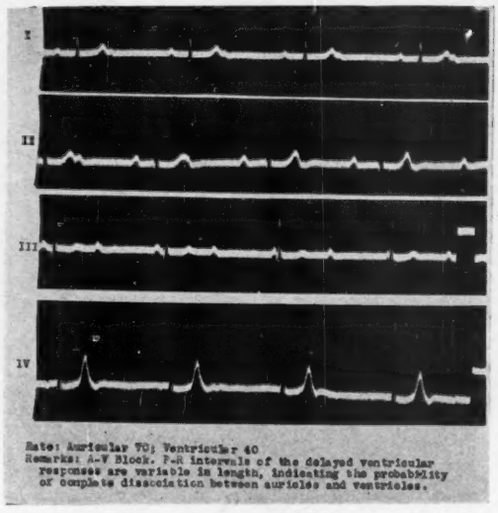
I
II
III
IV
Rate: Auricular 70; Ventricular 40
Remarks: A-V Block. P-R intervals of the delayed ventricular responses are variable in length, indicating the probability of complete dissociation between auricles and ventricles.

FIG. 7. Electrocardiogram thirteen months postoperatively showing heart block.

By the seventh postoperative day the colostomy was functioning daily without irrigation. The abdominal wound was dressed and the clips removed. Elastoplast as an outer dressing keeps the skin clean and dry; it is an ideal dressing, being waterproof as well as supportive. Uneventful convalescence continued, wounds were clean and healing normally, patient voiding and having a daily normal bowel movement via the colostomy. He was up on the twelfth postoperative day and his temperature was normal. Pulse variation remained between 40 and 60, urine contained 25 pus cells per high power field, erythrocyte count and hemoglobin were within normal limits, and leucocyte count was 19,000. On the next day, temperature was 101°F. and there was an increase in the number of pus cells in the urine, but no retention. The posterior cavity appeared to be granulating normally and was being irrigated daily. Sulfathiazole was administered orally, 15 gr. four times daily. The following day his temperature went up to 104°F. Sulfathiazole determination in the blood reached a level of 3 per cent and medication was stopped. Inspection of the posterior cavity revealed some excess granulation with bridging across high in the hollow of the sacrum. This was broken down with a gloved finger and daily irrigations continued. This may have been the origin of our hernia.

On the fifteenth day, temperature was down to normal, patient was up and about and the urine was clear again. This reaction and the temperature of 104°F. were probably due to a pus pocket or infection in the posterior area of the bladder and the reconstructed pelvic floor, inasmuch as the blood sulfathiazole level remained low and the urine cleared up immediately. An electrocardiogram on the sixteenth day revealed the heart block as described previously, ventricular 43, auricular 86. (Fig. 3.) The pulse rate during the three febrile days remained between 50 and 60 per minute.

At this time, the internist suggested that ephedrin, gr. $\frac{3}{8}$ at three-hour intervals, might release the heart block. This was given for forty-eight hours, when the patient refused to take any more as it kept him awake. His pulse rate remained between 40 and 60 during his entire stay in the hospital of twenty-five days. The surgical shock, the temperature of 104°F. and the ephedrin every three hours had no effect on the pulse rate, which never went above 68 during the entire time.

The patient went home 25 days after admission with the abdominal wound healed, the colostomy functioning daily without irrigations at any time, the posterior cavity granulating normally, and with the urine clear and voiding normally. The posterior cavity irrigations were to be continued at home every two days, followed by the insufflation of sulfathiazole powder. He was seen in the office six weeks postoperatively and improvement continued normally. He returned to work eight weeks postoperatively as store clerk in the tool department. The posterior cavity was not completely healed, as the skin edges were not approximated, but apparently granulation was complete otherwise.

Three months postoperatively, healing was complete in the posterior area as well as the abdominal incision. The patient was feeling fine and was back to his former weight. He was having a daily bowel movement without an enema, nocturia once or twice nightly, and the urine was clear. Examination one month later revealed the colostomy stoma large enough to admit the index finger. There was no evidence of hernia in the abdominal wall. The posterior area was completely healed, and there was a slight bulge on standing at the sacral end of the scar. There was no pain at any time. One month later, the bulge on

coughing was considerably larger, involving about half of the posterior scar. The patient was informed of the condition, but he felt fine and had worked constantly with no discomfort in any area.

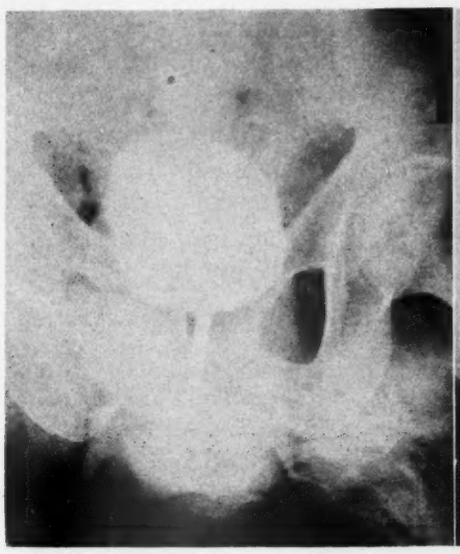

Fig. 8. Cystogram, anteroposterior view, with hernia protruding.

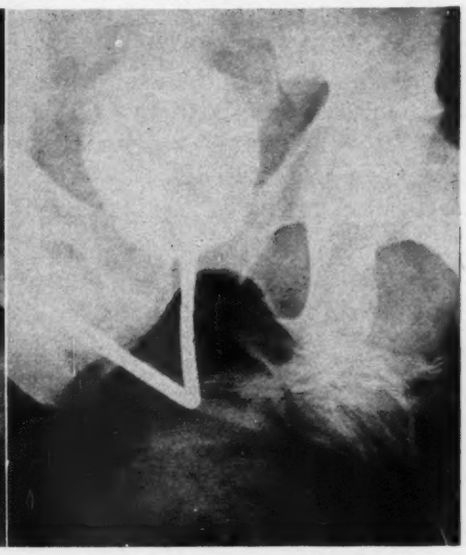

Fig. 9. Cystogram, anteroposterior view, with hernia completely reduced.

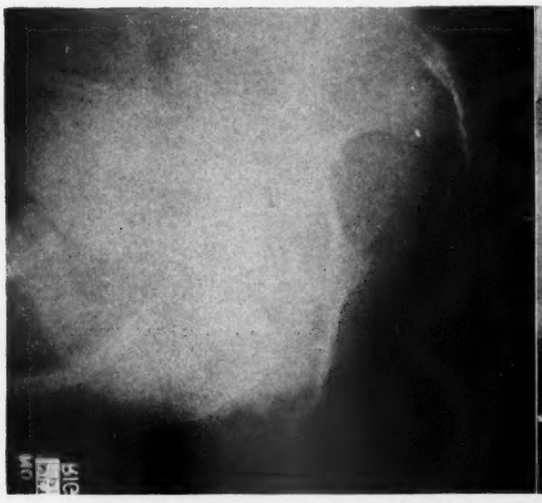

Fig. 10. Cystogram, lateral view, with hernia protruding.

Fig. 11. Cystogram, lateral view, with hernia completely reduced.

He returned two months later with the entire posterior cavity bulging on standing. When placed in the knee-chest position, the hernia reduced itself. By this time the hernia was quite large, but the patient still had no complaints and could see no reason why anything should be done as it was not bothering him. (Figs. 4, 5 and 6.) Sitting was just the same as ever. When seen next time, one year postoperatively, the patient had just completed painting his house on the outside. He had lost no time from work and felt fine. The colostomy was functioning daily with no help.

At the present time, the hernia is about the same as it was four months previously. It is no larger, as it fills the entire pelvis on straining and reduces when lying down. On straining, the skin is taut and looks as though it would burst. The patient says, "It does not bother me, so why worry about it?" The patient's pulse rate remains the same. An electrocardiogram made thirteen months postoperatively by Dr. Durkin reveals no change except perhaps increasing myocardial damage. (Fig. 7.)

Not being clear on what fills the posterior cavity in these parts with the removal of the rectum, levator muscles, etc., it was decided to take cystograms in the anteroposterior and lateral positions, thinking the bladder might have prolapsed posteriorly into the hernia. However, this was proven not the case, as the bladder remains in normal position. (Figs. 8, 9, 10 and 11.) With the hernia reduced, the prostate is easily palpated through the skin.

SUMMARY

1. A white male patient with a large palpable carcinoma of the rectum had been treated for six months without ever having had a rectal examination.

2. The same patient withstood a prolonged abdominal perineal resection with a pulse rate never exceeding 70 per minute.*

3. A colostomy functioned normally without ever having had an irrigation.

4. A large postoperative perineal reducible hernia occurred which causes the patient no discomfort.

5. The bladder remains in a normal position.

6. The patient is well satisfied, has no complaints, and is unwilling to have anything done about the hernia since it does not bother him in any way.

* My choice of anesthetic for the surgery described in this paper was pentothal sodium, but the nurse anesthetist had greater self-assurance in using cyclopropane.

FEMORAL hernia is acquired and of gradual development. While some authorities think it arises always from a congenital sac or diverticulum, it is rare before the age of twenty and the femoral canal is not normally open at birth. Therefore, it may be considered an acquired condition. The swelling is usually small, rounded or globular, the neck lying inferior and lateral to the pubic spine and the inguinal ligament.

From "Principles and Practice of Surgery" by W. Wayne Babcock (Lea and Febiger).

UNUSUAL FOREIGN BODY IN RECTUM*

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AND

LIEUT. CHARLES HONIG
MEDICAL CORPS, ARMY OF THE UNITED STATES

MANY reports of foreign bodies in the rectum have appeared in the literature which we do not propose at this time to review exhaustively. It is well known that in ancient times the introduction of various solid bodies was practiced as a method of punishment. Foreign bodies have been forced into the rectum with criminal assault and sometimes in depraved pranks; but more commonly are introduced by the patient himself in connection with some form of sexual perversion. There is hardly any object commonly available which has not been recovered from the rectum either by manual extraction from below or by laparotomy.

Among the objects that have been reported are: a snuff box, whiskey glass, a 30 cm. mortal pestle, a bullock's horn 11 inches long, electric light bulbs, an ink bottle, a vaseline bottle, a cold cream jar and lemon, an apple, chicken bones, glass tube, portion of a broom handle, frozen pig's tail, a stick measuring 32 cm. in length, a cylindrical candle box 6 inches in circumference and 2¼ inches in length, a tool box containing a piece of gun barrel, a screw driver, two hacksaws, a boring syringe, a file, several coins, thread and tallow. The predilection seems to be, naturally, for solid cylindrical objects easily accessible at the time that the individual resorts to preversion when under alcoholic or sexual compulsion.

Entirely apart from foreign bodies introduced through the anus, foreign bodies may enter the rectum from above following their ingestion often without a distinct history so that they are accidentally discovered in the course of routine rectal examination. Most common are the animal or fish bones which become caught in the lower rectal or anal tissues.

This is a case report of an unusual foreign body removed from the rectum and sigmoid colon. The object was a plantain, a member of the banana family, about nine inches long, which the patient had encased in a latex rubber sheath (condom).

A plantain is a kind of banana of the genus musa parapisiaca sometimes considered as a variety of the common musa sapientum. The fruit of this plant when cooked is a staple article of food throughout the tropics. It is larger than the ordinary banana which it resembles, greenish in color, less sweet, and contains more starch.

CASE REPORT

J. R., a thirty-seven-year-old Puerto Rican male, came to the Emergency Ward of the Flower and Fifth Avenue Hospital on February 5, 1945, complaining of rectal bleeding associated with rectal and lower abdominal pain of three hours' duration. Three hours before admission, he had inserted the plantain into his rectum while under the influence of alcohol. Various attempts made by the patient to remove the foreign body were unsuccessful. Manipulations in the rectum with a pair of scissors were followed by profuse bleeding.

On examination, the temperature was 99°F.; pulse, 100; respiration, 22; blood pressure, 140/90. He was complaining of severe pain in the rectum and moderate lower abdominal pain. His breath was aromatic. Examination of the abdomen revealed no evidence of spasm or rigidity, moderate tenderness over the entire lower abdomen, no rebound tenderness, distention, nor evidence of free fluid. A rigid mass, compatible in shape with that of a large banana was palpable in the lower abdomen. On rectal examination, a considerable amount

* From the Department of Surgery, New York Medical College, Flower and Fifth Avenue Hospitals and Metropolitan Hospital; Dr. Louis Rene Kaufman, Director.

of bright red blood was encountered in the rectal ampulla. The lower end of the foreign body was easily felt and on bimanual examination was continuous with the mass felt abdominally. On proctoscopic examination, one could see what looked like the stem of a banana high in the rectal ampulla. Repeated attempts to extricate the foreign body by means of finger with pressure on the abdomen, and the use of forceps and clamps were unsuccessful, the object apparently being firmly lodged in the rectosigmoid. Failure was also due to the inability to obtain a proper hold on the stem which either slipped away or shredded when instruments were applied.

Under general anesthesia, in the operating room, with the patient in a lithotomy position, the plantain along with the encasing condom was removed via the rectal route. We were unable to obtain any grasp of the lower end of the plantain with ordinary forceps, volsella, or ring forceps. A shepherd's hook was inserted with its point protected by the finger, guiding it into proximity to the lower third of the object. The point of the hook was then forced well into the object which was held steady by the assistant's hands, pressing it downward from its abdominal end. By gentle traction with the hook, the rough lower end was gradually delivered as the folds of mucous membrane were separated with the finger. The frayed and roughened, thick stem was found incarcerated in these folds, offering the obstacle to previous efforts at extrication. Proctoscopic examination revealed numerous deep abrasions of the lower portion of the rectal ampulla and anus with deep congestion of the mucosa and some oozing but no active bleeding.

Postoperatively, the patient was given full doses of sulfasuccidine by mouth and rectal instillations of sulfasuccidine suspensions. He was observed for three days; no untoward reactions were noted, no temperature or pulse rise and no changes in abdominal signs occurred. Proctoscopic and sigmoidoscopic examinations on the third day revealed a hyperemic and edematous rectal mucosa with scattered areas of punctate hemorrhages. No other pathological condition was seen. Following psychiatric consultation, a diagnosis of a bisexual individual with a strong latent homosexual impulse was made. He was discharged for follow-up in the psychiatric clinic.

SUMMARY

This is a case report of an unusual foreign body, a plantain covered by a condom, removed from the rectum and sigmoid of a bisexual male, thirty-five years old. The difficulties encountered in the extrication were due to the slippery nature of the object, its tendency to shred at the stalk and to the catching of the rolled edges of the condom in the folds of the rectal mucosa. Recovery was uneventful; sulfasuccidine was given orally and by rectal instillations as prophylactic measures.

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TRAUMATIC LUXATION OF THE TESTIS

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WAR with its violence, speed and multitudinous mechanical appliances, causes many casualties not directly associated with combat. These are accidental injuries of great variety and varied severity. One of the rarer and unusual of these injuries recently came to our attention on the Urological Service of a Regional Station Hospital.

CASE REPORT

On December 6, 1943, a twenty-four year old soldier presented himself, complaining of the loss of both testicles. He stated that this occurred in November, 1941, while debarking at a Ferry Command Base. He was assisting in transferring cargo from a ship to a barge when he slipped and fell, landing astride the gun wale of the landing barge. Excruciating pain immediately followed in the perineum and lower abdomen, causing him to lose consciousness. During the transfer to shore, which occurred immediately, he regained consciousness and was assisted to the beach where he rested three hours. During this time a severe, nauseating, but gradually diminishing pain was present throughout the lower abdomen, and at the end of three hours he was able to assist in light work. For the next three or four days he did only odd jobs not requiring physical exertion and then returned to full duty, never seeking medical care. He was aware on the day of the injury that the testes were out of the scrotum, and reasoned that they must have been pushed into the abdomen.

He said that prior to the injury both testicles were in the scrotum. The right testicle had always been in the upper part of the scrotum and was somewhat smaller than the left, which he attributed to a herniorrhaphy at the age of five. The left testicle was, in his opinion, of normal size and in the normal scrotal position. Following the injury he did not recall ever voiding bloody urine, nor that there was discoloration of the perineum or the lower abdominal wall. In fact, in his memory, there never were any external signs of injury except the empty scrotum. There were likewise no changes evident to him in his personality, ability to work or sexual power.

After nearly two years of full duty he was returned to the States. At the local Reclassification Center the defect was noted by the medical examiner, and he was referred to us for correction of the defect. Examination revealed a completely empty, small, contracted scrotum A transverse suprapubic scar was present slightly to the right of the midline. The right inguinal canal was empty, and the right testicle could not be found. A tender mass the size of a testicle was felt in the subcutaneous tissue over the area of the left internal inguinal ring. The remainder of the physical examination and laboratory tests were normal.

A diagnosis of bilateral luxation of the testes was made. On December 11, 1943, the left testicle was surgically replaced in the scrotum. This was done by way of the usual hernia incision. The testicle was found to be normal in size, lying over the internal inguinal ring and attached to the subcutaneous fat by many adhesions. The external oblique fascia had been split and its edges widely separated from the external inguinal ring to the position occupied by the testicle at the internal ring, thereby unroofing the inguinal canal throughout its entire length. There was no hernia.

After freeing the testicle from its adhesions to the surrounding tissue no difficulty was encountered in placing it in the scrotum for the cord was completely free and was readily drawn from the abdomen. The testicle and scrotum were then anchored to the thigh with a single suture of silk. Closure of the inguinal canal was accomplished by suturing the conjoined tendon to the inguinal ligament over the cord. After finding the separated edges of the external oblique fascia it was imbricated. Number 40 interrupted cotton sutures were used throughout. No attempt at any surgical interference was made on the right side since there was no testicle palpable and the inguinal canal appeared intact.

An uneventful convalescence followed and the patient was discharged to full military duty on January 23, 1944.

In 1936, Herbst and Polkey found ninety-two cases reported in the literature which they classified as testicular luxations. They added one case of their own. In this group they included twenty-eight cases of herniation of the testis and five cases of cryptorchidism, which we believe are not true luxations. They did not include seven cases which Dombrowsky mentioned as having seen in Russian Army Recruits in whom, with one side of the scrotum empty, a testicle was found lying in the subcutaneous tissue at the external inguinal ring, the result of self-mutilation to avoid military service. This would leave a total of sixty-seven cases. Since their review of the subject four cases have appeared in the literature, namely, the cases of Bourgeois, McRea, Ott and Shannon, making a total of seventy-one cases of true testicular luxation.

It appears to us to be confusing and incorrect to classify scrotal injuries, in which the testicle is denuded of its scrotal covering, as cases of luxation of the testicle. They have been designated as herniae testes, compound dislocations, or compound luxations by previous writers, but always included under the general topic of luxation. Some of these cases in turn were actually an avulsion of the scrotum and should not be included under either classification. They are the cases of Barthelemy et Miramond De Laroquette, Golden, Tournus des Gonets and Wolf. The subject might be greatly clarified if the designation, herniation of the testicle, was limited to those cases in which a rent in the scrotal wall has occurred permitting the testicle to lie outside of the body, devoid of its scrotal covering. Whereas, in cases of luxation of the testicle, the integument of the body remains intact and the previously normally located testicle assumes a non-scrotal position by being forcibly propelled through normal anatomical apertures or along fascial planes.

There are thirteen cases of luxation of the testis, including the one we are reporting, recorded as occurring in military personnel. Of this group there are but two bilateral luxations; the one reported by Claubry as occurring in 1809 and the present case. The total number of bilateral luxations recorded in the literature is eight. This is then not only a very dramatic but exceedingly rare injury as well.

Among the immediate causes producing luxation of the testis are accidents, such as, a run-over by heavy vehicles, falling astride an object a direct blow to the scrotum, saddle injuries, sudden severe muscular efforts, coitus, ill-fitting trusses and self-mutilation. Some of the patients may have had an underlying congenital anomaly or anomalies permitting extreme mobility of the testis which might have been a predisposing factor in the cases associated with muscular effort or coitus, but the cause, as in our case, is usually of such severity that a minor congenital anomaly is not a necessary factor.

The positions as described by Alyea to which the testicle may be dislocated are: superficial fascia of the lower abdomen, dorsum of the penis, perineum, crural area of the thigh, inguinal canal, femoral canal and abdominal cavity.

The symptoms and findings depend upon the type and severity of the injury to the surrounding tissues. These findings may vary greatly, but there is usually extreme nauseating pain with or without vomiting, an empty scrotum and except in cases in which the luxation has been into the abdomen, a tender palpable testicle in one of the areas described in a preceding paragraph.

The treatment, except in rare instances, is surgical. Early attempts at replacing the testicle have occasionally been successful without surgery. If non-surgical replacement is impossible, early surgery to replace the testicle is indicated.

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There is much in common between infectious and inflammatory processes and the metastases of cancer, yet there is no evidence that infection plays any part in the process except as a complication of ulcerative carcinomas.

From "Metastases Medical and Surgical" by Malford W. Thewlis (Charlotte Medical Press).

BILATERAL BRANCHIAL CLEFT CYST

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THE origin and pathogenesis of so-called congenital cysts and fistulas of the neck has long been an interesting and controversial subject. Wenglowski, in 1912, after thorough study and dissection of seventy-five embryos and 246 cadavers, propounded his theories on the origin of lateral cervical cysts and fistulas. He emphasized the fact that the branchial system begins to develop in the human embryo in the second half of the first month, and that during the second month, perhaps even in the first half, this system is lost. He believed the branchial system to be more a part of the head than the neck, and no branchial remnants were to be found below the lower border of the hyoid bone. It followed that any cysts, fistulas, or other anomalous structures below this level must be of other than branchial origin.

Bailey disagrees with Wenglowski in that he believes some cysts and fistulas which appear below the hyoid bone to be of branchial cleft origin. He points to cervical auricles and the case of a persistent branchial cartilage situated in the lower part of the neck, where a cyst usually opens, as evidence of the fallacy of Wenglowski's hypothesis. Bailey prefers to approach the subject from a clinical point of view.

Sutton says that fistulas arising from the second visceral cleft open, externally, opposite the thyrohyoid space in front of the sternomastoid muscle and, internally, in the tonsillar fossa. He further says that fistulas arising from the third and fourth visceral clefts open, externally, lower down, nearer the sternoclavicular articulation, in front of the sternomastoid muscle, and internally, in the sinus pyriformis.

Peterson, in his exhaustive and excellent review of the subject of congenital cysts and fistulas of the neck, mentions that Dr. Franklin R. Carter has operated successfully on a case of bilateral congenital fistulas of the neck. Pictures of the patient and the specimens are included. In a review of the literature, as complete as the tactical situation in a theater of operations will permit, I am unable to find another case of successfully operated bilateral congenital fistulas of the neck and, consequently, I report this as an unusual case.

I do not feel qualified to enter into a discussion of the origin of this fistula and cyst, but, in this case, both sides opened, externally, at the level of the thyrohyoid space and 3 cm. lateral, and, internally, both opened in the tonsillar fossa. According to Sutton's description, then, these fistulas originated from the second visceral cleft.

Although the origin of these cysts and fistulas is very debatable, the treatment which gives the most uniformly good results is radical surgical excision. Cutler and Zollinger have recently reported several cases in which the patients were treated with sclerosing solution with good results. The case to be presented was treated by bilateral surgical excision, one side at a time, and the result is excellent at this time, seven months later.

CASE REPORT

The patient, a male, age twenty-eight years, entered this General Hospital March 1, 1944, after having been injured in an automobile accident in which he incurred a laceration of the forehead 2 inches long and a small linear fracture of the outer table of the skull in the frontal region. His recovery from his injuries was very rapid, and we were asked to see him because of a draining fistula on each side of the neck.

The patient's history was entirely negative, except for the usual childhood diseases and a tonsillectomy at the age of twenty-four. At

eight years of age the fistulas of the neck were first noticed but gave little trouble except that the one on the right began to drain a small amount of mucoid material and had continued to do so right up to the time of examination. The fistula on the left side gave no trouble until the patient was twenty-one years old, when it began to undergo periods of inflammation, suppuration, and drainage, interspersed with periods of quiescence. Twice it had to be opened. At the time the patient entered the Army, it was in a quiescent phase, but it had suppurated twice since then. The patient was put on a limited duty status due to the continually draining sinus on the right and retained this status up to the time of this examination.

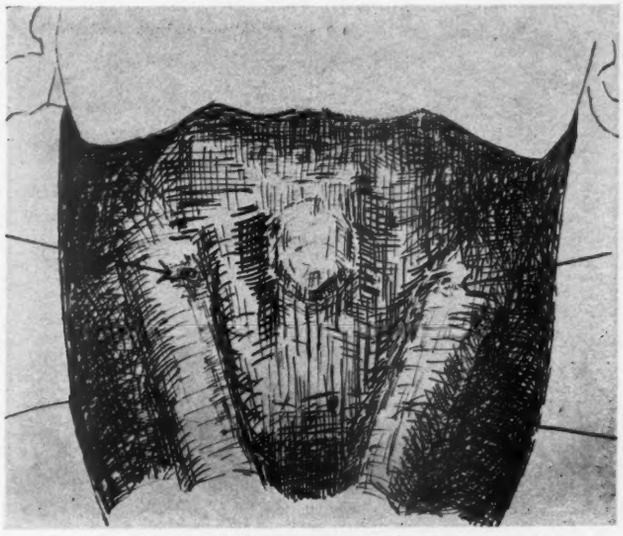


Fig. 1. Arrows indicate external fistulous openings.

General physical examination of the patient on March 15, 1944, was entirely negative except for the neck. Examination of the neck (Fig. 1) revealed, on the right side, a 3 mm. opening at the level of the thyroid cartilage and 3 cm. lateral to it, which exuded a mucoid secretion continuously. There was no tenderness on palpation, but on applying downward pressure, it was thought a cord could be felt running upward and medially. On the left side, instead of an opening, there was a dimple of comparable size. Above and around this dimple was an area of induration and tenderness. Both sides moved slightly with deglutition.

On March 16, 1944, the patient was taken to the *x*-ray department and an intravenous cannula was introduced into the opening on the right side and held in place by a purse-string suture. A small amount of mucoid material was aspirated, and then the fistula was filled with a mixture of lipiodol and mineral oil in equal parts, and an *x*-ray was taken. At the time of the injection the patient complained of a bitter taste in his mouth, and the *x*-ray revealed the mixture to have traveled upward and medially to a point just below the mandible, and then posteriorly, a total distance of 4.5 cm. Similar examination of the left side was impossible due to the presence of infection. It was decided to

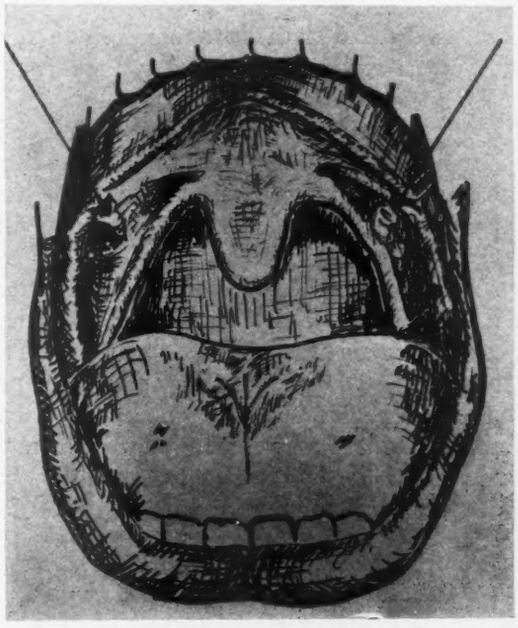
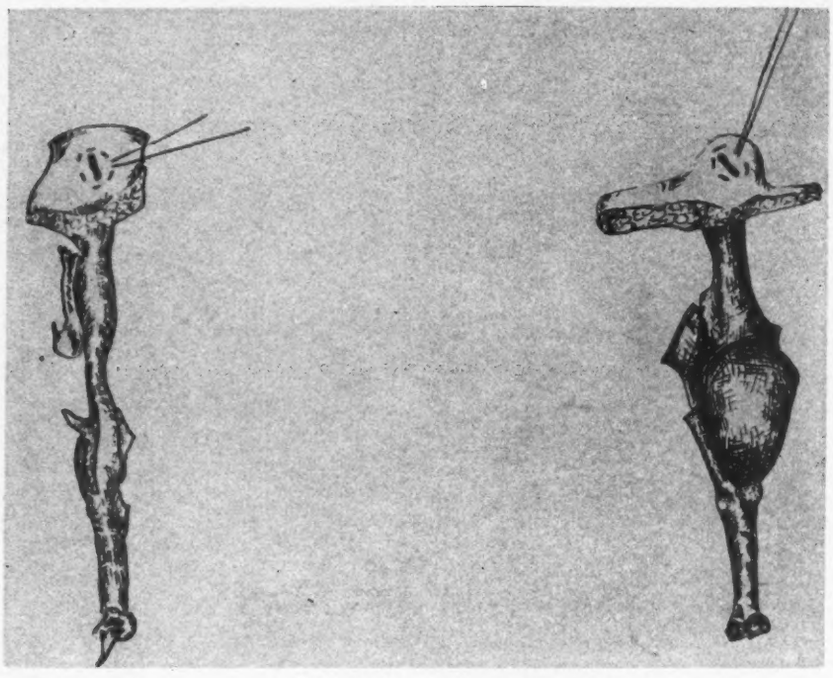


Fig. 2. Arrows indicate internal fistulous openings in tonsillar fossae.

delay operating for ten to fourteen days because of the recent skull fracture and the presence of the inflammation on the left side.



A B

FIG. 3. A, fistulous tract from right side; B, cyst and fistulous tract from left side.

It was also decided to do one side at a time. Hot, wet dressings were applied to the left side, and the induration rapidly disappeared.

On April 2, 1944, under pentothal anesthesia, an intravenous cannula was again introduced into the opening on the right side, methylene blue introduced by injection, and the opening secured by a purse-string suture. (It is believed that inhalation anesthesia using an intratracheal tube is the anesthetic of choice in these procedures. This was avoided because of the straining and coughing incident to this procedure in the presence of a recent skull fracture.) An elliptical incision 5 cm. in length was made around the orifice and the tract, which was about 0.5 cm. in diameter, was dissected free past the medial border of the sternomastoid muscle, thence to the carotid sheath as far as the bifurcation of the common carotid artery, and then laterally under the posterior belly of the digastric muscle and the twelfth (hypoglossal) nerve. At this point a finger was placed in the mouth and a probe guided into the pharynx through the fistula, and into the posterior portion of the tonsillar fossa. (Fig. 2.) All, save 0.5 cm. of the tract was then cut off, and the remainder was inverted into the pharynx by the method of Von Hacker. The subcutaneous tissues were closed with plain No. 0 catgut and the skin with silk. A small piece of latex tissue drain was introduced into the depth of the wound. The drain was removed on the second postoperative day, the sutures on the fourth day. (Fig. 3A.)

On April 7, 1944, an identical procedure was carried out on the left side. (Fig. 3B.) This side was slightly more difficult, technically, because of the many previous episodes of inflammation and the presence of a 1.5 cm-cystic dilatation of the tract 1 cm. from its origin. The specimens were drawn immediately after surgery in both cases.

Pathological study of both these specimens showed them to be lined by a rather flat, squamous epithelium, surrounded by areolar tissue, and a moderate amount of lymphoid tissue. The specimen from the left side showed the result of its previous episodes of inflammation in the presence of fibrous tissue and the cells of chronic low-grade inflammation.

The patient left the hospital on April 25, 1944, reclassified to a full duty status, and has just reported to me by letter (seven months later) that he has had no soreness, no difficulty of any kind, and considers himself completely well.

SUMMARY

1. The conflicting theories of the pathogenesis and origin of lateral cervical cysts and fistulas are presented.

2. The diagnosis, *x*-ray findings, and surgical management of a case of bilateral branchial cleft cyst are reported.

3. The patient is completely well after seven months.

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Thyroglossal cysts not infrequently become infected and are incised and drained. Such treatment may be indicated to control infection, but will not effect a cure. Complete excision of the cyst with the thyroglossal tract is the only curative treatment. Excision up to the hyoid bone is not sufficient. The dissection should be continued to the foramen cecum.

From "Operations of General Surgery" by Thomas G. Orr (W. B. Saunders Company).

New Instruments

VISIBLE GUIDE FOR NAILING INTRACAPSULAR FEMORAL NECK FRACTURES*

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IN the so-called "blind" method of internal fixation of intracapsular femoral neck fractures, the surgeon is confronted with the problems of determining the course of direction the nail should take prior to its insertion and guidance of the nail during insertion. The apparatus herein described is presented because of its simplicity, accuracy, and ease of application.

The purpose of the instrument designed by the author is twofold: (1) Determination of direction, and (2) visible guide during insertion.

The apparatus as shown in the accompanying photograph (Fig. 1) consists of a chromium plated steel collar (A), which is fixed on the nail driver (B) by two set screws. From this collar there extends a square steel bar (C), which is at right angles to the collar (A). The guide rod (D) is attached to the upright bar by means of a clamp (E), which is fitted with two set screws, which allow for raising or lowering the guide rod, or moving it medially or laterally, depending upon the size of the patient.

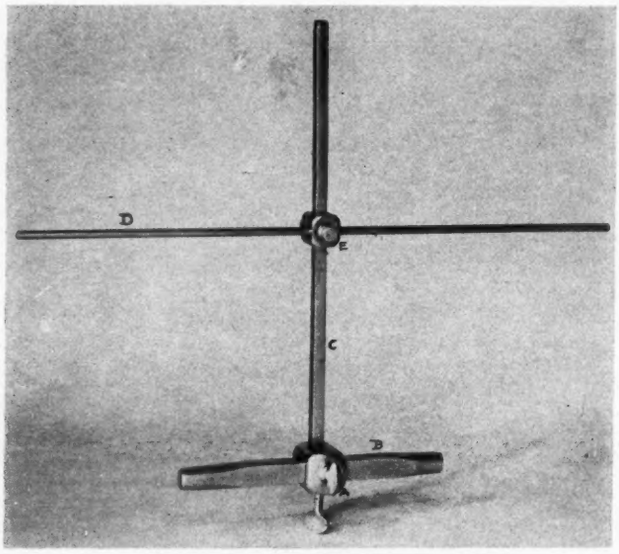


FIG. 1. Instrument assembled ready for use.

When this instrument is attached for use, the guide rod and driver are parallel to each other, in a vertical plane and are maintained in this position throughout the operation. In addition to being parallel, the guide rod also is in true alignment with the point of the nail and the center of the driver in its longitudinal axis, thus assuring accuracy in nailing.

* From the Surgical Service of Beekman Hospital, New York.

The use of the apparatus presupposes proper reduction of the fracture before proceeding. In the use of the direction finder a grid consisting of one-half inch wire mesh 4 inches by 4 inches with lead numbers attached, is placed on the skin over the anterior aspect of the inguinal region, so that the center of it bisects Poupart's ligament. This grid is held firmly in place by several Michel clips, or silk sutures to the skin, and kept in full view of the operator. An *x*-ray is now taken and the position of the femoral head and neck can be noted with respect to the numbers on the grid as shown in the accompanying *x*-ray photograph. The grid was first used at the Beekman Hospital by Dr. Donald Gordon, Dr. S. A. Siegel, and Dr. L. V. Marrone. However, any other type of skin indicator may be used in place of the grid in conjunction with the visible guide.

The usual incision is made along the lateral aspect of the upper end of the femur and the bone exposed. A point is selected on the center of the shaft about ¾ to 1 inch below the inferior edge of the great trochanter. A punch mark is made by means of a center punch at this point on the shaft of the femur, which represents the point of entrance of the nail. The assembled guide as shown in the photograph is now ready for use in the following manner: The point of the nail is placed on the shaft of the femur at the center punch mark; the guide rod is now placed

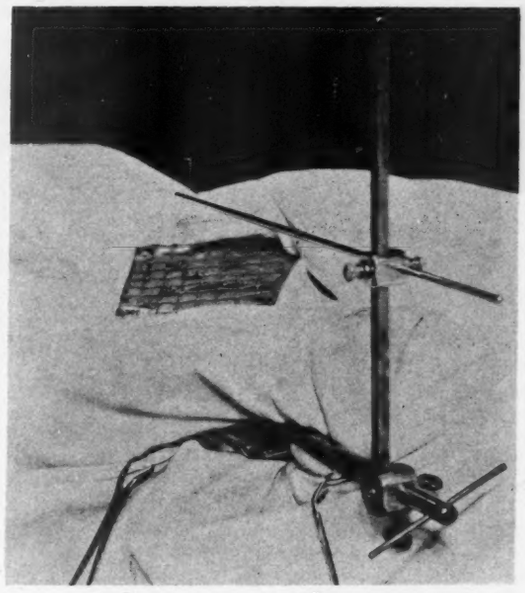
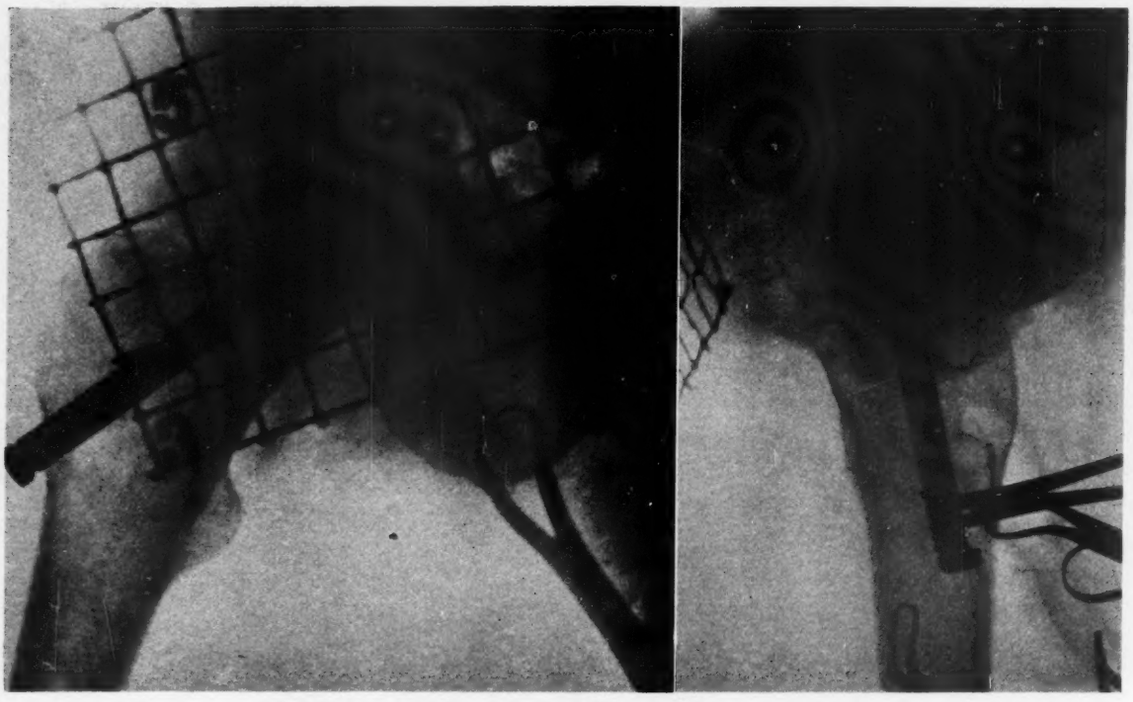


Fig. 2. Instrument in actual use (nail partly in femur).

Fig. 3. Nail partly in femur; guide rod superimposed and in direct line with nail indicating its course.

along the course indicated by the numbers on the grid; all set screws are then made tight, and with the apparatus held firmly with one hand the nail is driven into place.



A B

FIG. 4. A and B, anteroposterior and lateral views of nailing completed.

A check-up *x*-ray may be taken when the nail has been driven about one-half its length. On this *x*-ray it will be noted that the guide rod and nail are parallel, and in alignment, thus enabling the surgeon to complete the nailing under vision of the guide rod, assuring proper direction. The wound is closed in the usual manner. Operative asepsis is not endangered by the use of the direction finder, due to the fact that no additional instruments such as wires or Steinman pins are introduced into the wound.

The visible guide has been used on six cases at the Beekman Hospital with marked success resulting in more accurate nailing, shortening of operating time, and conservation of *x*-ray film. It may be used with any of the various types of nails by substituting the respective driver.

The apparatus as shown has been adapted for use with the Smith-Petersen and Dooley type of nails.

SUMMARY

A new instrument* has been presented to facilitate accurate nailing of intracapsular femoral neck fractures, which possesses the following advantages: (1) Direction and course of the nail are visible to the operating surgeon. (2) No part of the guide apparatus enters the operative wound. (3) Operating time can be shortened. (4) It eliminates repeated *x*-ray check-up plates.

*This instrument is manufactured by Edward Weck & Co., Inc., Brooklyn, N. Y.

COLOSTOMY CLAMP

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THIS clamp (Fig. 1) has been in use for eight years and has proved its value in: (1) early decompression of an obstructed bowel with an absence or decrease in bowel distention, nausea, vomiting and ileus; (2) permitting early ingestion of fluids and food; freedom of movement with comfort and safety of the patient; (3) preventing danger of bowel perforation by catheter inserted through bowel wall below ordinary clamp; soiling of wound by bowel contents being diverted through catheter for several days; tearing of bowel by accidental traction of long handled clamp; retraction of short colostomy before firm adherence to abdominal wall.

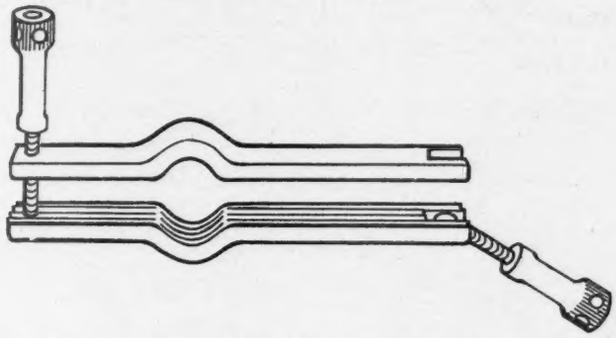

FIG. 1. Clamp consists of two blades, each with a half circle depression. These are held in place by two set screws, one of which is hinged, and whose heads contain small holes for the insertion of a pointed instrument to facilitate the tightening.

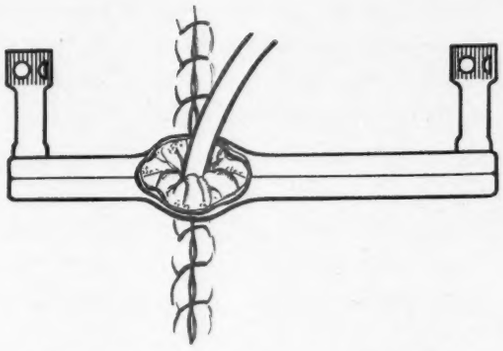

FIG. 2. Clamp appled to single barrelled colostomy.

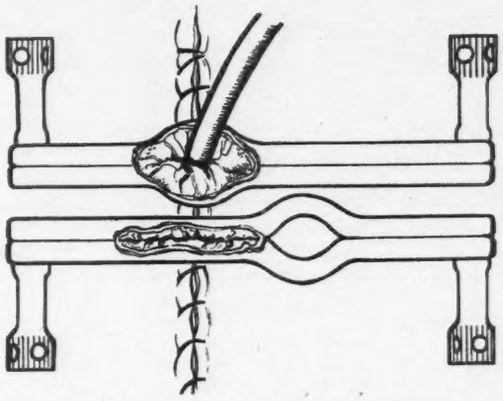

FIG. 3. Clamp appled to double barrelled, Mikulicz or Devine colostomy.

Application. After the wound has been closed and covered with vaseline gauze, the bowel is grasped with Allis forceps on each side below the clamp with which the bowel is closed; the colostomy clamp is slipped beneath this first clamp with the curved section approximating the bowel lumen. Flat gauze sponges are placed between the colostomy clamp and the wound dressings. The original clamp is removed after the cauterized edge of the bowel has been grasped on each side by forceps. A lubricated No. 24 to No. 26 mushroom

catheter with two additional openings cut in the bulb is inserted with a small forceps into the open end of the bowel just below the clamp. (Fig. 4.)

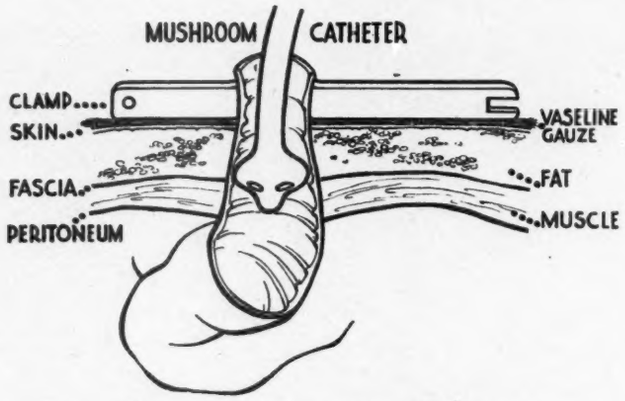

Fig. 4. Mushroom catheter in place.

The clamp (Fig. 1) is designed with the opening placed off center allowing the straight portion to be applied to the distal end of a double barreled colostomy (Fig. 3) or to the proximal end if the operator is fearful of leakage.

This clamp* is used in a single colostomy (Fig. 2); double barreled colostomy (Fig. 3); Mikulicz or Devine colostomies (Fig. 3); cecostomy and ileostomy. The clamp on the distal loop may be left *in situ* until the bowel sloughs. In performing a cecostomy a fold of the bowel is drawn through the wound and held with Allis forceps, the catheter is inserted through an opening made with a cautery and the clamp tightened in place. The appendix may be removed by being included in the clamp.

The catheter is kept open by the injection of 30 cc. of air several times the first postoperative day and water the second. The Harris flush is attached on the second or third postoperative day.

* The clamp may be purchased from the Ed. Holz Surgical Company, of Los Angeles, California.

NEW SELF-RETAINING RETRACTOR

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NEW YORK, NEW YORK

THIS retractor is a great help in the operating room in this era of man power shortage, in that it dispenses with the need of an assistant to hold retractors.

As can be seen in the illustration, the device consists of (1) a ring with numerous slots around its periphery, which circles the operative field, (2) metal spring bands which pass around the part of the body operated upon and hold the slotted ring in place and (3) chains with a hook at one end. The figure shows how the retractor is used for a mastoid operation. The ring is placed in position before the incision. After the incision is made, the hook of a chain is fastened into one side of the incision, pulled back as far as it will go and a link of the chain nearest a slot is slipped into the slot. It is held from slipping by the next link. The hook of another chain is fastened into the other side of the incision opposite the first hook, that chain is pulled taut and a link inserted into its appropriate slot. As many hooks and chains can be used as needed. The pull of the chains from opposite directions keeps the ring from shifting sideways. There is a minimum of encroachment on the operative field.

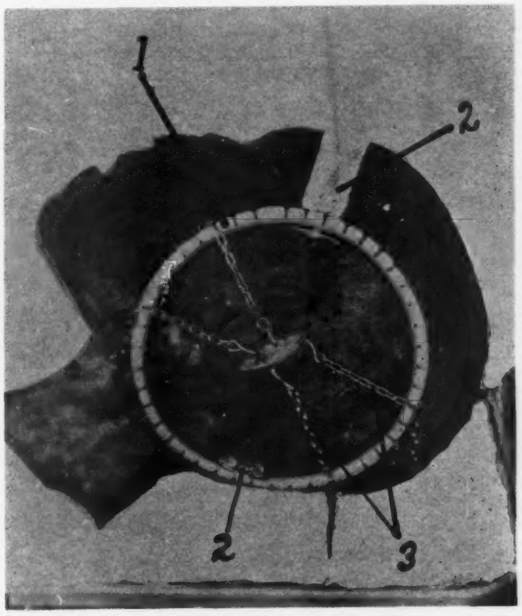

FIG. 1. Use of retractor for mastoid operation.

This retractor can be made in various sizes and can be used on almost every part of the body.

SPECIAL ARTICLE

MALFORMATIONS OF THE UTERUS*

REVIEW OF THE SUBJECT, INCLUDING EMBRYOLOGY, COMPARATIVE ANATOMY, DIAGNOSIS AND REPORT OF CASES

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NEW YORK, NEW YORK

IT is now recognized that congenital anomalies of the uterus are not mere anatomical curiosities but are potentially serious conditions which warrant the careful consideration of every gynecologist and obstetrician. To the gynecologist a knowledge of these abnormalities is helpful in clarifying obscure and refractory cases of sterility or of menstrual disorder. To the obstetrician the ability to detect uterine malformation can be of great usefulness in averting dangers which threaten mother and child. Since it often happens that uterine anomaly is responsible for abortion, miscarriage, premature and difficult delivery, or uterine rupture, early diagnosis may be necessary and even urgent.

THE MÜLLERIAN DUCTS

Since malformations of the uterus are referable to developmental arrest or deviation of the Müllerian ducts, a brief review of the embryology of these structures is of practical value. During the sixth week of embryonic life, the Müllerian ducts become visible. They are directed longitudinally and are in close proximity to the more developed Wolffian ducts. The insertion of the ligamentum inguinale, which eventually becomes the round ligament, into the urogenital cord differentiates two sections in the Müllerian ducts. The segments located above this area of demarcation remain ununited and eventually form the fallopian tubes. The distal segments of the Müllerian ducts move in a medial direction and eventually lie side by side. During the twelfth to fourteenth week, the medial wall formed by the fusion of the two Müllerian ducts disappears and fusion is completed by the formation of a single medial canal—the uterogenital canal. Further differentiation results in the formation, from below upward, of the structures which develop into the vagina and uterus.

Details have been omitted in this brief description because the various stages of embryonic development are readily seen in the schematic drawing. This figure has been simplified in order to avoid confusion and to give a clear picture of the development of the uterus. (Fig. 1.)

* From the Department of Obstetrics and Gynecology, Sydenham Hospital, New York City.

In view of the intricacy of the processes which result in the formation of the uterus, it is not at all surprising that frequent disturbances in development, with subsequent malformation, should result. Many theories con-

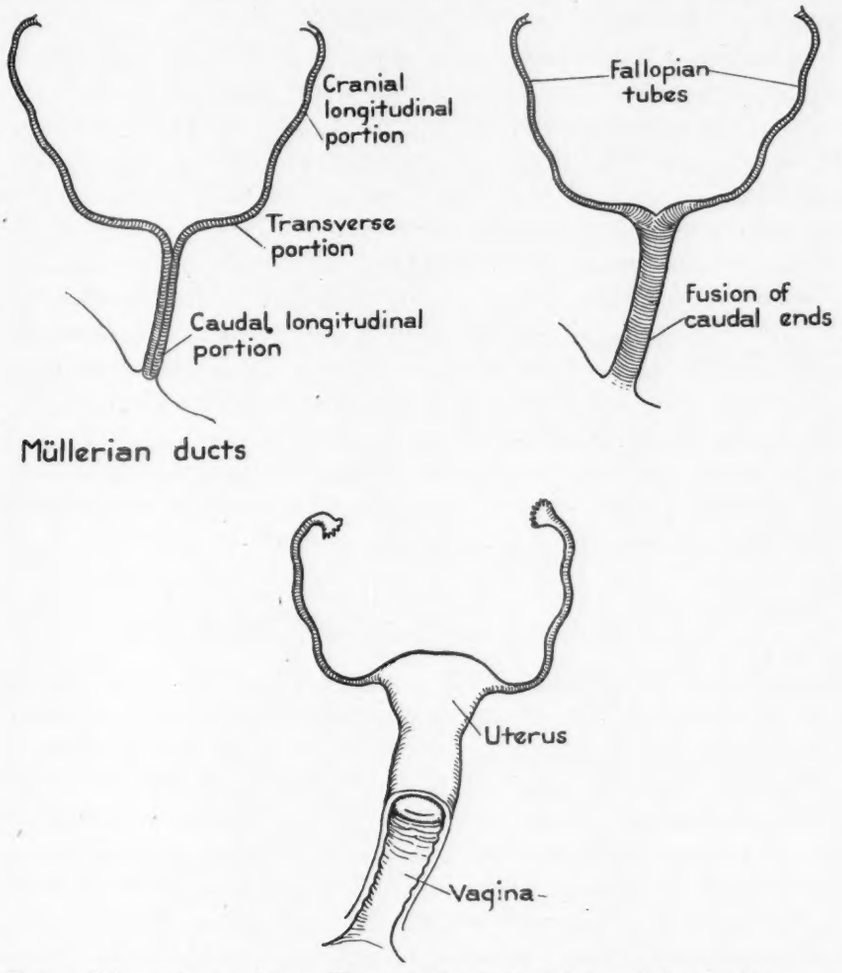

FIG. 1. Schematic drawing to illustrate the fusion of the Müllerian ducts to form the uterus and vagina.

cerning the etiology of uterine anomalies have been advanced, but, as is pointed out by Masson and Kaump, their very number suggests that proof is lacking.

Many of the earlier theories concerning the development of uterine anomalies have been concisely summarized by Granberry and Faust (1938), but it is obvious that none of them explain all the varied malformations encountered in clinical practice or at autopsy. Falls (1939) has expressed the opinion that hormonal failure in intrauterine life might be chiefly responsible for the improper fusion of the two halves of the uterus, as well as for other

developmental deficiencies in this organ. On the basis of an observation made by Felix in 1912, Anderson believes that many uterine anomalies can be explained on the ground that the left Müllerian duct usually advances slightly ahead of the right and that an error of timing during embryological development might result in a malformation.

It has been suggested that both defective germ plasm and unfavorable embryonic environment are among the most important factors in the production of malformations of the uterus (Curtis 1942; Rogers and Blocksom). However, like other experienced workers (Bailey and Miller, DeLee and Greenhill, Moncure, Braze), I am inclined to take the less complicated view that various types of uterine anomalies can be attributed to abnormal fusion or lack of fusion, in whole or in part, of the Müllerian ducts. In other cases, the anomaly of the uterus is probably due to rudimentary development of one duct, or perhaps, its almost complete suppression, as might well be the case in instances of uterus unicornis. It is, of course, quite probable that any one or a combination of unknown factors will greatly influence the degree or localization of fusion, or the lack of proper embryological development, but of this we cannot be certain. From a purely clinical viewpoint we must be on the alert to recognize the presence of such anomalies, whatever their cause, and to treat the patient in accordance with the findings.

TIME OF OCCURRENCE OF MALFORMATIONS

Through our knowledge of embryology attempts have been made to fix the time during development when uterine anomalies are most apt to occur. According to Schattenberg and Ziskind, unilateral or bilateral failure of development may occur during the first month, while uterus didelphys, with double vagina and uterus, may form during the second month, because of failure of fusion of the two sides. Arrested development on one side may give rise to a rudimentary horn. Uterus bicornis or uterus arcuatus may form during the third or fourth months because of incomplete fusion of the two Müllerian ducts. The septum may persist or a single or double cervix may develop. Schattenberg and Ziskind remark that the only malformation that occurs after the fifth month is uterus arcuatus. Although a uterus may appear normal externally, it is also quite possible that it may contain a persistent septum, which may or may not continue into the vagina to give rise to uterus septus duplex or uterus and vagina septus duplex.

TYPES OF UTERINE ANOMALIES

Between the premature uterus didelphys and the almost normal uterus arcuatus, a large number of uterine anomalies are possible. This has led to complex and unwieldy systems of classification. The early confusion of unclassified forms and varied nomenclature was partly clarified in 1922

when Kaufmann introduced his schema. This classification, modified slightly by Frank and others, remained the basic system for many years. Kaufmann divided uterine anomalies into four basic groups, each of which had several

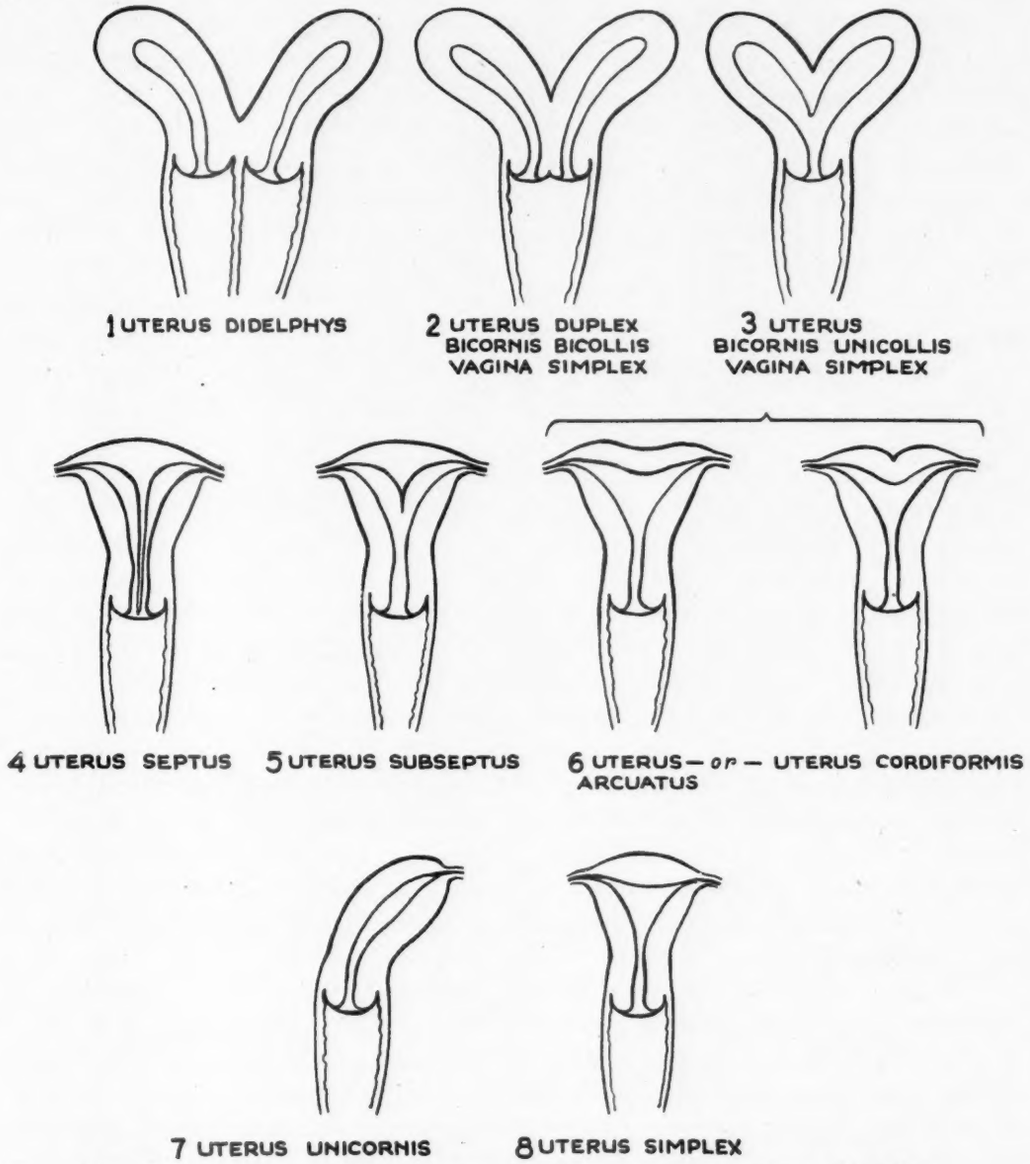
1 UTERUS DIDELPHYS
2 UTERUS DUPLEX BICORNIS BICOLLIS VAGINA SIMPLEX
3 UTERUS BICORNIS UNICOLLIS VAGINA SIMPLEX
4 UTERUS SEPTUS
5 UTERUS SUBSEPTUS
6 UTERUS — or — UTERUS CORDIFORMIS ARCUATUS
7 UTERUS UNICORNIS
8 UTERUS SIMPLEX

FIG. 2. Normal uterus and seven types of malformation of the uterus and vagina.

subclasses. The basic groups were: (1) Malformations due to faulty juxtaposition of Müller's ducts; (2) malformations due to faulty absorption of septa; (3) malformations due to aplasia, and (4) malformations due to hypoplasia.

Today there is a marked tendency toward even further simplification. Beck in his newer text lists thirteen principal forms. In 1943, Taylor suggested further simplification and proposed a system of five basic categories. As a result of my own experience, I believe that this extreme degree of simplification is undesirable. I have found that a list of seven variations will include most cases of uterine anomaly. For this reason, I propose the use of the following types as more truly representative: (1) Uterus didelphys; (2) uterus duplex bicornis bicollis, vagina simplex; (3) uterus bicornis unicollis, vagina simplex; (4) uterus septus; (5) uterus subseptus; (6) uterus arcuatus or cordiformis, and (7) uterus unicornis.

The accompanying illustration makes detailed description of these forms unnecessary. (Fig. 2.)

Since each type listed in this schema represents a distinct stage or phase in development, it is quite simple to fit any variation of form into the proper category. For example, uterus bicornis uno latere rudimentarius (with open or closed horn) would properly belong in the third category—uterus bicornis unicollis, vagina simplex.

Uterus Didelphys. Uterus didelphys, in which there is duplication of the vagina, cervix and uterus, is comparatively rare. Cases of this type are usually reported in great detail when discovered. The diagnosis is sometimes an ultimate result of difficulties encountered during pregnancy or labor (Shirley and Cogswell, Galloway, Healy, Perrigard, Keevil). As Findley has remarked, the anomaly is frequently unrecognized even in the event of childbearing. Often a patient may live a long, normal life without being aware of abnormality until some other pathological condition calls attention to the malformation. This occurred in the case of a sixty-six-year old woman reported by Young. The rarity of the anomaly is well illustrated in the statistics gathered by Smith from the records of the New York Lying-In Hospital. During a twenty-five-year period there were four cases of uterus didelphys in 114,243 consecutive obstetrical patients admitted to the hospital. In the subsequent period of five years, one instance was found in 27,703 patients.

From the clinical standpoint the importance of uterus didelphys is its relation to pregnancy and labor. While fertility and pregnancy are not markedly affected, the chances of normal birth at term are greatly reduced. In fifty-four patients studied by Miller there had been a total of sixty-seven pregnancies, only twenty-eight of which (42 per cent) occurred normally and at term. Abortion and interruption of pregnancy were the chief causes for the low rate of normal birth. In the group of eleven cases reported by Schauffler (mostly uterus didelphys), there were thirty-three pregnancies, of which seventeen or 53 per cent resulted in abortion or miscarriage. These failures were attributed to the fact that intrauterine septums and irregularities of the fundus are poorly vascularized, the musculature being thin and

irregularly disposed while the stroma is inadequate. Findley attributes importance to the behavior of the non-gravid uterus. Acting as an appendix to the pregnant uterus, it may be dragged behind the gravid organ and it

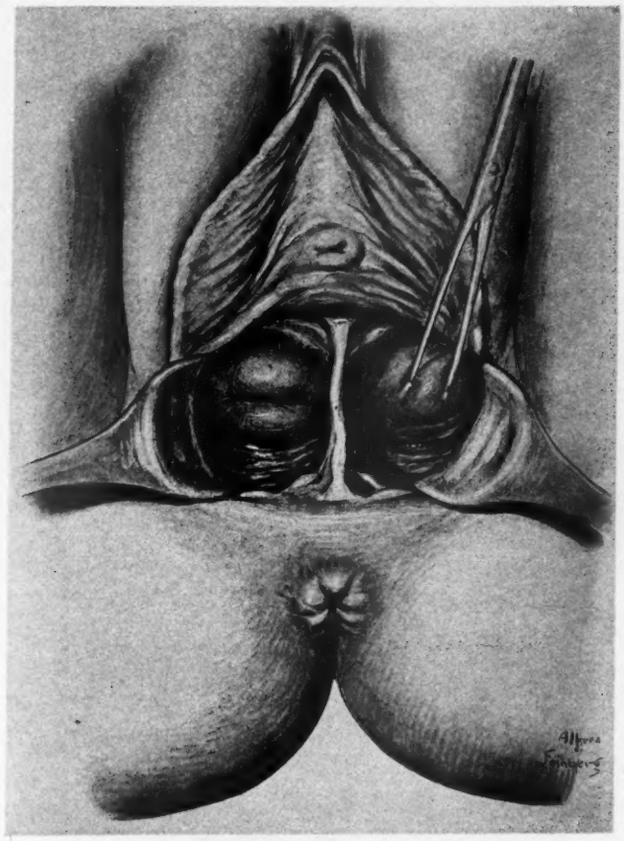

FIG. 3. CASE 1, G. M. Uterus didelphys. Note the two cervices and septate vagina. (From Julius Jarcho, in "Gynecological Roentgenology," 1931. By permission of Paul B. Hoeber, Inc. Publishers.)

may retard the progress of labor by becoming incarcerated in the hollow of the sacrum. In addition, it may contract during labor, thereby contributing to the labor pains. Very commonly a decidual membrane is expelled on the second or third day of the puerperium.

Findley's findings in 135 cases of uterus didelphys are relatively encouraging. In his series of cases, 217 full-term babies were born. There were eighty-three spontaneous deliveries, twenty-three cesarean sections, one craniotomy on a dead fetus, two Porro operations, one hemihysterectomy, and one death from rupture of the uterus. Findley found that abortion is relatively common in cases of uterus didelphys and that labor is prolonged

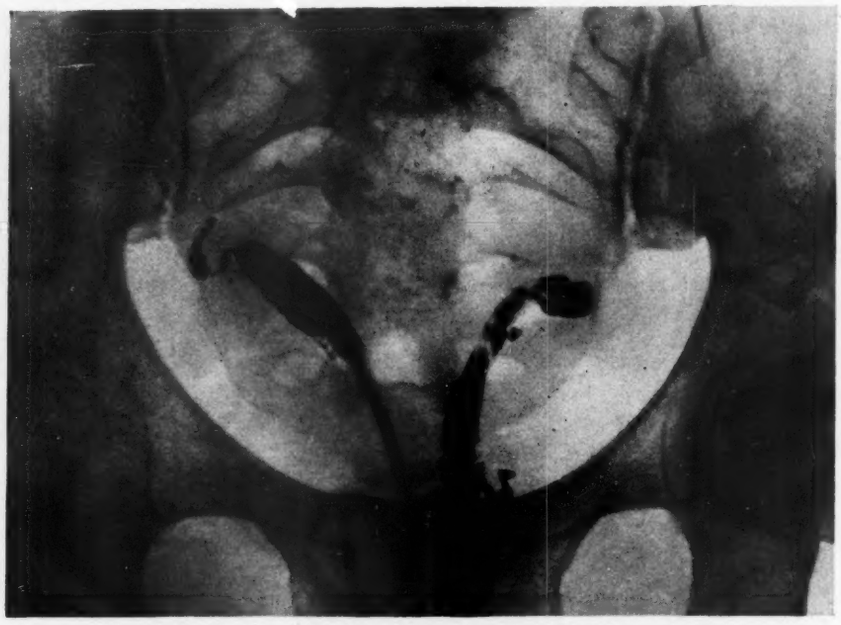

FIG. 4. CASE 1, G. M. Uterosalpingogram of same case. (From Julius Jarcho, in "Gynecological Roentgenology," 1931. By permission of Paul B. Hoeber, Inc. Publishers.)

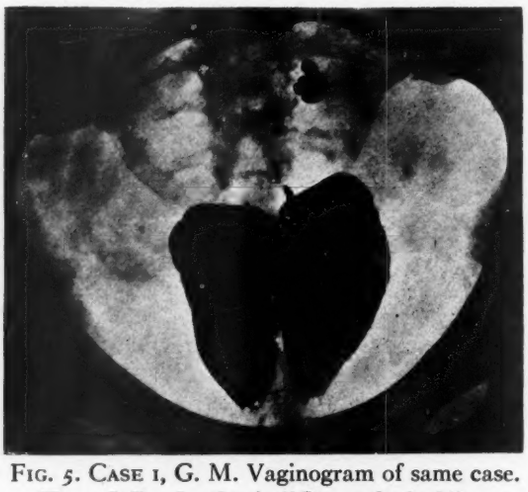

FIG. 5. CASE 1, G. M. Vaginogram of same case. (From Julius Jarcho, in "Gynecological Roentgenology," 1931. By permission of Paul B. Hoeber, Inc. Publishers.)

as a result of poor muscular development in the uterus, a small rigid cervix, and the encroachment of the non-gravid uterus. (Figs. 3, 4 and 5.)

Multiple Pregnancies in Uterus Didelphys. Though quite rare, twin pregnancies have occurred in women with uterus didelphys. In the case reported by Moncure, cesarean section was employed to deliver two babies, who were easily resuscitated. In the case recorded by Corbet, a live fetus was delivered spontaneously from the right uterus and three days later a second living child was born. Each uterine component behaved as an independent unit and went into labor at a different time. Thus, while the right uterus was in strong labor, the left cornu was quiescent. Of great interest is the observation of Davies and Cellan-Jones that pregnancy may occur alternately in the horns of uterus didelphys.

I have personally observed eighteen cases of congenital uterine anomaly and one case of fibroid uterus which simulated an anomaly. The pertinent data are summarized as follows:

One patient gave birth to one living child
One patient gave birth to three living children
One patient gave birth to two living children and one stillbirth
Two patients gave birth to two living children each (total four children)
Total—ten living children and one stillbirth
Three patients were pregnant once and aborted
One patient had five pregnancies and aborted five times
Six patients were sterile
Three patients had no uteri
One patient had fibroid simulating uterus bicornis
After removal of the fibroid and a plastic operation on the uterus, the patient gave birth to a living child

Confusion in Terminology. A certain amount of confusion has developed in the terminology of uterus didelphys, because some writers have used the term only for cases in which there were two separate parturient canals and bipartite vulva, an extremely rare condition. This confusion is partly attributable to the very unusual case reported by Gemmell and Paterson in 1913. In this instance there was complete duplication of the internal and external genitalia, including duplication of the bladder, uterus, vagina, and vulva. Despite this duplication there was no interference with pregnancy and labor, and living children were born from each set of genitalia. Except for the absence of an umbilicus and the presence of an "enormously" wide pelvis the patient was normal. Of interest was the fact that the intestinal viscera could be palpated between the two vulvae.

The only other case of double vulva found by Gemmell and Paterson was one reported by J. Suppiger. Recently another instance of double vulva was described by Patterson and Maxwell. Although in this case the external genitalia were double, the uterus was single and was connected to the right vagina. The small left vagina did not have an opening into the pelvis.

The paucity of examples of uterus didelphys associated with double vulva is sufficient reason for discarding the confusing term "uterus pseudo-didelphys" which has been used to denote duplication of the uterus, cervix and vagina unaccompanied by duplication of the vulva. A double vulva is not necessary for the classification. A similar opinion has been expressed by Shirley and Cogswell, and common usage does not make a distinction (Sweet). Where vulval duplication does exist, the term uterus didelphys cum vulva duplice would be more accurate.

Uterus Duplex Bicornis Bicollis. Uterus duplex bicornis bicollis vagina simplex differs from uterus didelphys chiefly in the fact that duplication of the vagina is absent. However, many of the difficulties encountered in uterus didelphys are applicable to this form as well, and in a general way it may be said that the conditions applying to uterus didelphys apply also to this anomaly.

Uterus Bicornis Unicollis. In uterus bicornis unicollis vagina simplex, or bicornate (bicornute, bicornuate) uterus, fusion is complete to a point above the cervix, incomplete absorption of the fundic segments resulting in the uterus being widely bicornate. As with other anomalies in which the uterus is double, pregnancy may occur in either or both horns. As a rule, pregnancy in one horn remains undisturbed, and the non-gravid horn produces a decidual membrane which often is expelled without disturbance of the gravid horn. Such an occurrence was reported by Wong. At six months, signs of miscarriage ended in the expulsion of a decidual cast of the non-gravid horn; three and one-half months later there was a normal delivery from the other horn.

The chief complications of pregnancy in bicornate uterus are hemorrhage and incarceration of one of the horns during labor. Braze (1943) in a review of the literature observed a lack of adequate reports of simultaneous pregnancy in the two horns of a bilateral uterus. Braze found no instance of successful termination of such pregnancy with viable children. His own report was exceptional and described a case of pregnancy in each horn which delivered spontaneously. However, this occurrence was followed in three months by prolapse and incarceration of the left horn of the uterus. The patient recovered after hysterectomy.

Special complications may arise when one of the horns is rudimentary. Perrigard cites reports which indicate that 80 per cent of rudimentary horns possess a canal which does not communicate with the vagina. It is therefore

obvious that pregnancy in a rudimentary horn may cause serious consequences. Adam considers pregnancy the most dangerous complication of double uterus because rupture of the gestation sac is almost inevitable about mid-term if the condition remains undiagnosed. Rupture, moreover, is associated with profuse hemorrhage. The mortality rate from this accident is acknowledged to be high (Stander).

Not as infrequently as is generally supposed (Crossen and Crossen), pregnancy in a rudimentary horn acts much like tubal pregnancy with all dangers inherent in such accidents. Then too, as indicated by Frank, a rudimentary atretic excavated horn may menstruate and eventually cause hematometra.

Uterus Septus. Outwardly a uterus septus usually appears normal. In some instances there may be a mild depression in the fundus. Internally, where the inner surfaces have failed to fuse, there is a septum which divides the cavity and which usually extends for the length of the uterus. With other so-called milder forms of bicornate uterus such as uterus subseptus and uterus arcuatus, the frequency of these deformities, according to Falls (1928), is estimated to be about 1 per cent. Falls has observed that anomalies of these types frequently give rise to complications, some of which might be avoided completely or minimized by proper diagnosis and evaluation.

The danger of the uterus septus, as explained by Luikart, lies in the fact that if pregnancy takes place in one half, the uterine wall of the other half hypertrophies and by its mere bulk may obstruct delivery from the pregnant half. Then, too, by simulating myoma, ovarian cyst, or extrauterine fetal sac, it may cause the obstetrician to make an erroneous diagnosis. If the septum extends only part of the way down, as in uterus subseptus, the ovum may be able to utilize sufficient uterine tissue to reach term and be born alive.

Uterus Subseptus. As a rule, uterus subseptus does not cause dystocia, but occasionally it may cause unfavorable obstetrical conditions by producing transverse or oblique presentation of the fetus. Attempts at version may offer the first indication of the presence of a septum. Sometimes, as Titus has stated, the fetal trunk may become engaged around the septum. This results in persistent transverse presentation, and cesarean section becomes necessary.

Uterus Arcuatus (*Cordiformis*). In 1939, Falls in an extensive report defined uterus arcuatus as "that form of bicornuate uterus in which the normal fusion of the two horns in embryonic life stopped just short of completion forming an organ which in the non-pregnant state can with difficulty be differentiated from a normal uterus but which, when pregnant, exhibits marked irregularities of contour." Externally, uterus arcuatus is marked by a fundal concavity. Where the line of demarcation is deeper and more definite, giving rise to a heart-shaped fundus, the malformation

is generally referred to as uterus cordiformis. On external examination only slight indentation (arching) of the fundus may be felt. Such uteri frequently contain a complete or incomplete septum. This can be determined only by

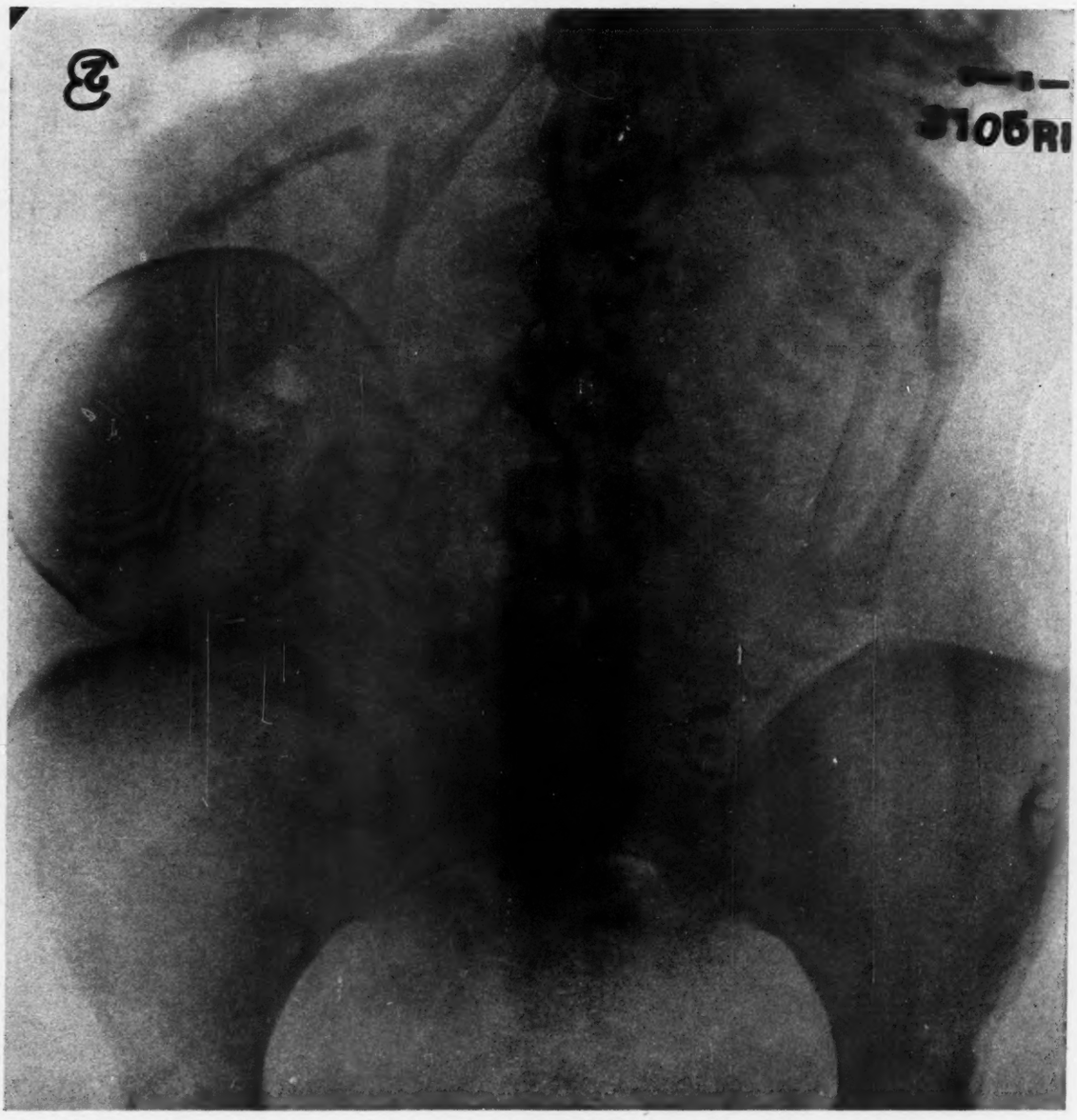

FIG. 6. CASE II, D. B. Roentgenogram shows fetus lying high above crest of ilium, the head in one cornu of the uterus and the legs in the other. (From Julius Jarcho, in *Am. J. Surg.*, 12: 417, 1931.)

uterosalpingography. Uterus arcuatus is one of the most common of uterine anomalies (Perrigard, Schauffler). Falls reported that of 7,553 deliveries recorded at the Research and Educational Hospital in Chicago, 155 were

associated with uterus arcuatus. Twenty-one (13 per cent) of these patients were delivered by cesarean section, while 134 patients were delivered vaginally. In the latter group labor was long and tedious, and many patients

FIG. 7. CASE III, A. S. Extirpated fibroid uterus. Large fibroid uterus with anterior wall of uterine cavity and supravaginal portion of cervix split open. One fallopian tube is seen.

failed to go into labor at term. It was necessary to induce labor in twenty-five (19 per cent) of the patients who were delivered from below.

Far from being unimportant clinically, uterus arcuatus is a malformation that requires careful consideration by the obstetrician since, as stated by Falls, the incidence of abnormalities in this group of patients is high. The complications of pregnancy were prematurity and postmaturity, while the complications of labor were prolonged first stage, breech and transverse presentation, sudden intrauterine fetal death, and retained placenta. In one of my cases of uterus arcuatus (Fig. 6, Case II), the patient was delivered normally of two children. In her third pregnancy she experienced sudden sharp abdominal pain two weeks before term. A roentgenogram revealed that the fetus lay high above the crests of the ilium. Under deep anesthesia

external cephalic version was performed. The head was held on pelvis for nearly an hour. Pains virtually ceased. Pituitrin 0.2 cc. was given to strengthen pains and facilitate engagement. The patient was delivered spontaneously of a living child which weighed six and one-half pounds.

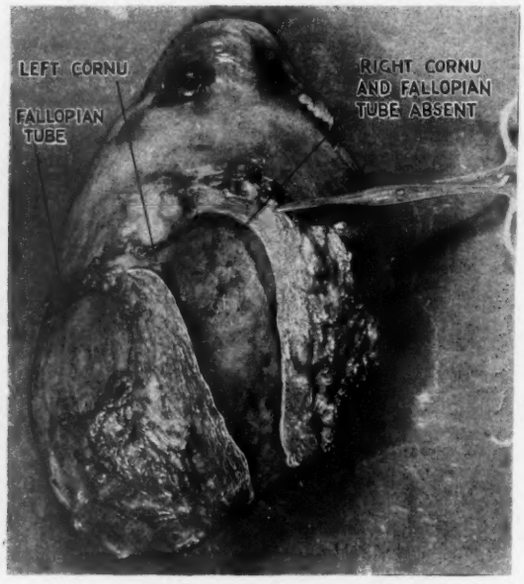

FIG. 8. CASE III, A. S. Extirpated fibroid uterus. Large fibroid uterus with anterior wall of uterine cavity and supravaginal portion of cervix split open. The entire uterine cavity is exposed. The right cornu and right fallopian tube are absent. The cavity of the left cornu and left fallopian tube is seen. Diagnosis: Fibromyoma of uterus; uterus unicornis.

In another of my cases of uterus arcuatus (Case XV), the patient was delivered of a normal living child. The patient had a large pelvis. Labor was short, but fetal heart sounds became irregular and delivery was made by low forceps. (Fig. 6.)

Uterus Pseudoarcuatus. Rudolf has called attention to "pseudouterus arcuatus" (sic!), a transient deformation of the uterus caused by temporary incoordination, which leads to functional malformation. Rudolf found that some degree of incoordination of each half of the uterus is not infrequent during pregnancy and labor. A definite differentiation between "pseudouterus arcuatus" and the true or anatomic type of uterus arcuatus can be made only postpartum. From physiological considerations Rudolf finds that it is not necessary to fear this functional complication or to fear malposition and malpresentation. The management of such functional malformations of the uterus is intelligent expectancy.

Uterus Unicornis. True uterus unicornis, caused by unilateral suppression of the Müllerian duct, is a very uncommon anomaly. In 1938, Shumacker was able to find only twenty-eight such cases in the literature.

FIG. 9. CASE IV, M. C. Uterus unicornis; roentgenogram after injection of iodized oil.

An additional instance was reported by Schattenberg and Ziskind in 1940 and another by Varino and Beacham in 1941. According to Stander, pregnancy in cases of uterus unicornis tends to be uneventful and the malformation is usually recognized only accidentally during operation or at autopsy. (Figs. 7, 8 and 9.)

COMPARATIVE ANATOMY

Students of comparative anatomy, and more recently gynecologists and obstetricians who have delved into the subject of uterine anomalies, recognize that a definite parallelism in structure exists between the various types of uterine anomaly in human beings and the normal genital organs of animals lower in the developmental scale. The importance of a wider knowledge of this parallelism lies in the fact that such information may lead to a clearer concept of human malformations and a better understanding of their management.

Failure of fusion of the Müllerian ducts in women assumes one of a definite number of forms, and as pointed out by Schumann, each of these forms has its direct analogue in the normal form of the uterus in one or more

of the lower orders of mammals. Schumann also remarks that the lower the species in the mammalian scale the less the tendency to fusion of the two sides of the genital tract.

Indeed the similarity is often so great that Blair-Bell has suggested the use of the word "atavism" in preference to "malformation" because the anomalous uterus often conforms exactly with that of one of the lower orders. In other words, women may have uteri which are found to be counterparts of the uteri of rodents, carnivores, insectivores, or subhuman primates.

According to Wilder the uterus is an adaptive organ, essentially a localized enlargement, which develops as needed. Thus, in viviparous sharks, such as the squalus, the expanded lower portion of each Müllerian duct becomes enlarged to form a uterus in which the embryos are retained until they have almost attained adult form. The same is true of certain salamanders. However, in none of these instances is the organ more than a container or brood cavity. There is no placenta nor is there any other direct connection between the embryo and the uterine wall.

The same is true also of certain lower mammals such as monotremes and marsupials, in which there is no placenta and the young are produced in a very immature state. It is only in the higher or placental mammals that the walls of the uterus become differentiated for nutrition of the embryo, and the uterus thereby becomes a physiologically active organ.

In mammals, starting with the lower species, all the theoretical intermediate evolutionary stages have their counterpart, ranging from double uterus to single uterus. Thus, as Walter states, monotremes have two separate uteri without vaginae, whereas marsupials have two separate uteri with separate vaginae. Among placental mammals a double uterus is found in certain rodents, such as the mouse, hare, marmot and beaver, and also in elephants, certain bats and the aardvark. A beginning of fusion between the two uteri is evident in pigs, cattle, certain rodents, certain bats and carnivores. A two-horned uterus is characteristic of ungulates, cetaceans, insectivores, and some carnivores, while a single uterus, the uterus simplex, is found in apes and humans.

A more detailed consideration of each of these species will serve to illustrate further the resemblance between the normal uteri of lower animals and anomalous uteri encountered in human beings.

Monotremes. In the egg-laying mammals or monotremes (e.g., the ornithorhynchus or duckbill of Australia and Tasmania; and the echidna or spiny anteater) the Müllerian ducts tend to fuse posteriorly while the anterior portions remain separate. In the monotremes, the uterus opens into a urogenital sinus (Neal and Rand). The so-called uterine portions are in reality oviducts. As described by Wilder, they are short, thick-walled, of rather large caliber, and entirely distinct from one another.

Marsupials. The marsupials or didelphians are represented by the opossum and the kangaroo. In the marsupials a vagina occurs and this may be regarded as representing an important stage in the evolution of the

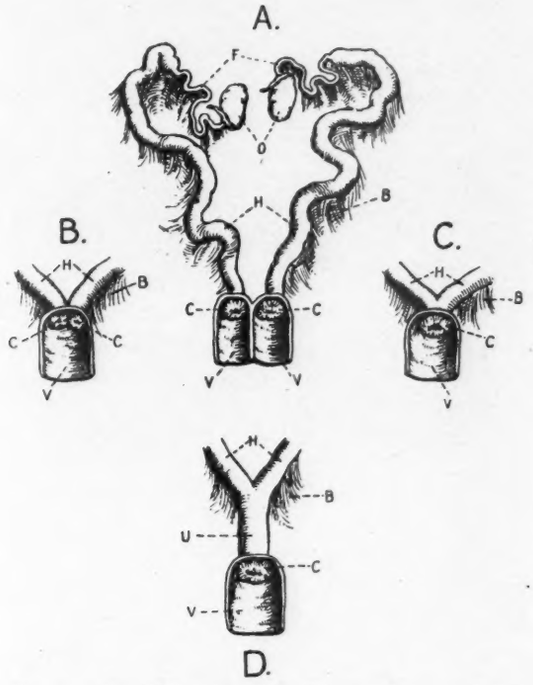

FIG. 10. Semidiagrammatic illustration to show the gradual evolution from the double uterus and vagina (A) of the lower rodents (e.g., Viscacha), and the double uterus with double os (e.g., Rabbit), or with single os (e.g., Aguti), and single vagina (B and C, respectively) to the bicornute uterus and single vagina of the carnivora (D). B, broad ligaments; C, cervix uteri; B, fallopian tubes; H, uterine cornua; O, ovaries; U, uterus; V, vagina. (From Blair-Bell in "The Principles of Gynaecology," 1934. By permission of Baillière, Tindall & Cox, London, Publishers.)

Müllerian ducts. In the opossum and kangaroo the uteri and lateral vaginae are connected with a central vaginal pouch, which has a more or less perfect longitudinal septum and ends blindly at the summit of the urogenital sinus (Blair-Bell).

Rodentia. The order rodentia (rabbits, squirrels, guinea pigs, porcupines, rats, gophers) offers examples of the transition from the primitive types of uterus to the more advanced forms (Owen). Two distinct uteri,

with separate cervices, are found in the lower species, such as the viscacha and rabbit. In the agouti the uterus is double but has a single cervix. In rodents the vagina, from being septate or double in lower forms becomes

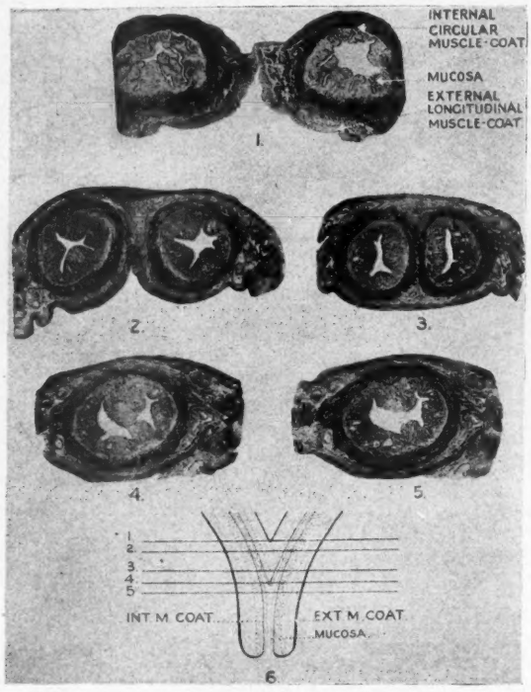

FIG. 11. A selection from serial sections of the uterus of the cat (1, 2, 3, 4, 5), showing the fusion of the two horns from where they first come together to below the point of complete fusion. The lines of section are made clear by the diagram (6). The way in which first the external coats, and then the internal coats, and finally the mucosae come together and fuse is clearly demonstrated. Fusion in the rabbit stops at stage 3, consequently that animal has two cervices surrounded by two circular muscle-coats and one external muscle-coat; (micro-photographs × 5). (From Blair-Bell in "The Principles of Gynaecology," 1934. By permission of Baillière, Tindall & Cox, London, Publishers.)

single in the higher members of the order. In pigmy musks Owen states that "the cornua of the uterus are unequal in size: the right was the largest in the specimen examined." (See Fig. 36, Case XII.) (Fig. 10.)

Carnivora. The next important step in development is found in the order carnivora (cats, dogs, weasels, bears, raccoons, seals) where the two

uterine bodies fuse in their lower parts to form a bicornate uterus. (Figs. 11 and 12, A, B and C.)

Ungulata. The order ungulata (hoofed animals) also offers examples

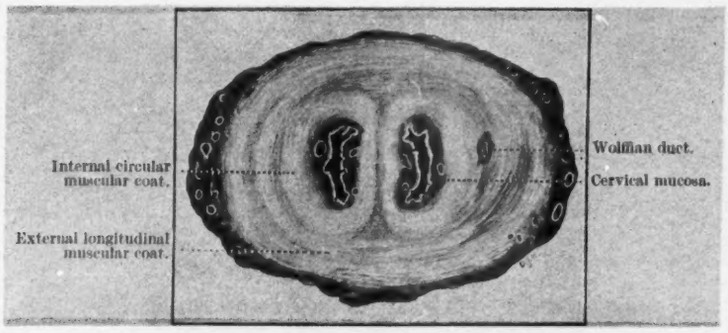

FIG. 12. Section through a double cervix (after Kelly). In the original description no mention was made of the beautiful way in which the muscular coats are demonstrated: the arrangement is identical with that seen in the rabbit. (From Blair-Bell in "The Principles of Gynaecology," 1934. By permission of Baillière, Tindall & Cox, London, Publishers.)

of the uterus bicornis. According to Patten, in the sow the fusion of the Müllerian ducts is carried only a short distance beyond the cervix to form a typical bicornate uterus. In his text on developmental anatomy, Arey cites the uterus of sheep as a typical example of bicornate uterus.

Primates. The uterus simplex, the highest form of uterine development, is found in the primates, which includes monkeys, baboons, apes and man. According to Neal and Rand (1939), a sub-order of primates, the lemuroids (including lemurs and tarsiers), have two-horned uteri (uterus bicornis). However, some of the lemuroids have arcuate or cordiform uteri.

Although, as noted by Perrigard, the uterus unicornis is normal in birds, Blair-Bell believes that this anomaly cannot be considered an atavism, but rather the result of the total suppression of one Müllerian duct.

Congenital Absence of Uterus. Although small or infantile uteri are quite common, complete congenital absence of the uterus is quite rare and it is very improbable that in the few cases reported there was absolute absence of all vestiges of the organ. Nevertheless, this seems to have occurred in the case of apparent congenital absence of uterus reported by Bowles and Burgess. Following the removal of an appendix in an eleven-year-old Korean girl, it was noted that the broad ligament of one side swept across the region where the uterus should have been and fused with its counterpart from the opposite side of the pelvis. No thickening was found that could be interpreted as the uterine body. The ovaries were normal, but vaginal examination revealed no apparent cervix.

TABLE 1

NON-PLACENTAL MAMMALS

Monotremes—Egg-laying mammals
(two separate uteri without vaginae)

Echidna or Spiny Anteater Ornithorhynchus or Duckbill		

Marsupials—Didelphians
(two separate uteri with separate vaginae)

Kangaroo Opossum		

Placental Mammals
(double uterus)

Aardvark Certain Bats Beaver	Elephant Hare Marmot	Mouse

Rodents
(with more advanced form of uterus)

Gopher Guinea Pig Porcupine	Rabbit Squirrel Rat	

Carnivores
(uterus bicornis)

Bear Cat Dog	Raccoon Seal Weasel	

Ungulates—Hoofed Animals

Sheep	Sow	

Primitive Primates—Half-apes

Lemur* (Lemuroids) Tarsier		

Primates
(uterus simplex)

Ape	Man	

* Some members of the lemur family have more advanced uteri (arcuate or cordiform).

Congenital Absence of the Vagina. As noted by Blair-Bell, a rudimentary uterus which is imperforate and consists mainly of fibrous tissue, is associated with absence of the vagina. Wharton attributes absence of the

FIG. A. Australian echidna or spiny anteater (an egg-laying mammal). (By permission of the American Museum of Natural History, New York.)

vagina to inhibition of the development of the Müllerian ducts. In this condition the growth of the ducts ceases very early in embryonic life. The ducts remain separate and do not fuse to form the uterus, cervix or upper vagina. Anderson (1931), however, takes a view opposite to that given by most writers. He is of the opinion that absence of the vagina and uterus is usually caused not by lack of fusion of the Müllerian ducts but by premature fusion.

For obvious reasons, abnormalities of the vagina are more frequently observed and reported than are internal malformations of the genital tract. Hence malformations of the vagina, such as atresia or complete or partial vaginal septum, are not considered rare. However, Reel, in a report of four cases of congenital absence of the vagina encountered during a twenty-three-year period, considers total absence of the vagina as probably the rarest congenital maldevelopment of the female genital tract. Various mechanical procedures and a variety of surgical technics have been developed to correct some of these abnormalities or to restore a degree of normalcy to others. A concise comprehensive review of the major surgical procedures for forming an artificial vagina was recently presented by Marshall.

Grave anomalies of the uterus are often accompanied by other serious errors of development, including not only vaginal atresia, but also such conditions as cloacal defects, atresia ani, vulvovaginal anus, malformations

FIG. B. Female kangaroo and its marsupium; note head of young in pouch. (By permission of the American Museum of Natural History, New York.)

of the abdominal wall, hernia, and other defects (Wharton). Occasional reports, such as those of Benjamin and Danforth and Siegel, describe bizarre combinations of developmental abnormalities associated with uterine anomalies. In Siegel's recent paper, the congenital anomalies noted in a twenty-one-day old infant consisted of: absence of right kidney and ureter, uterus didelphys, imperforate anus, imperforate vagina, pseudohydrocolpos, urethrosigmoid, (pseudohermaphrodismus femininus externus). Such a conglomeration of congenital anomalies is obviously incompatible with life.

Milder combinations of malformation also appear. For example, Ladd and Chisholm recently reported a case in which a double uterus and vagina was associated with duplication of the sigmoid and rectum with two external openings.

Uterine Anomalies Associated with Anomalies of the Urinary Organs. Since the embryonal predecessor of the Müllerian duct also contributes to the development of the urinary tract (Reel), it is not surprising that uterine

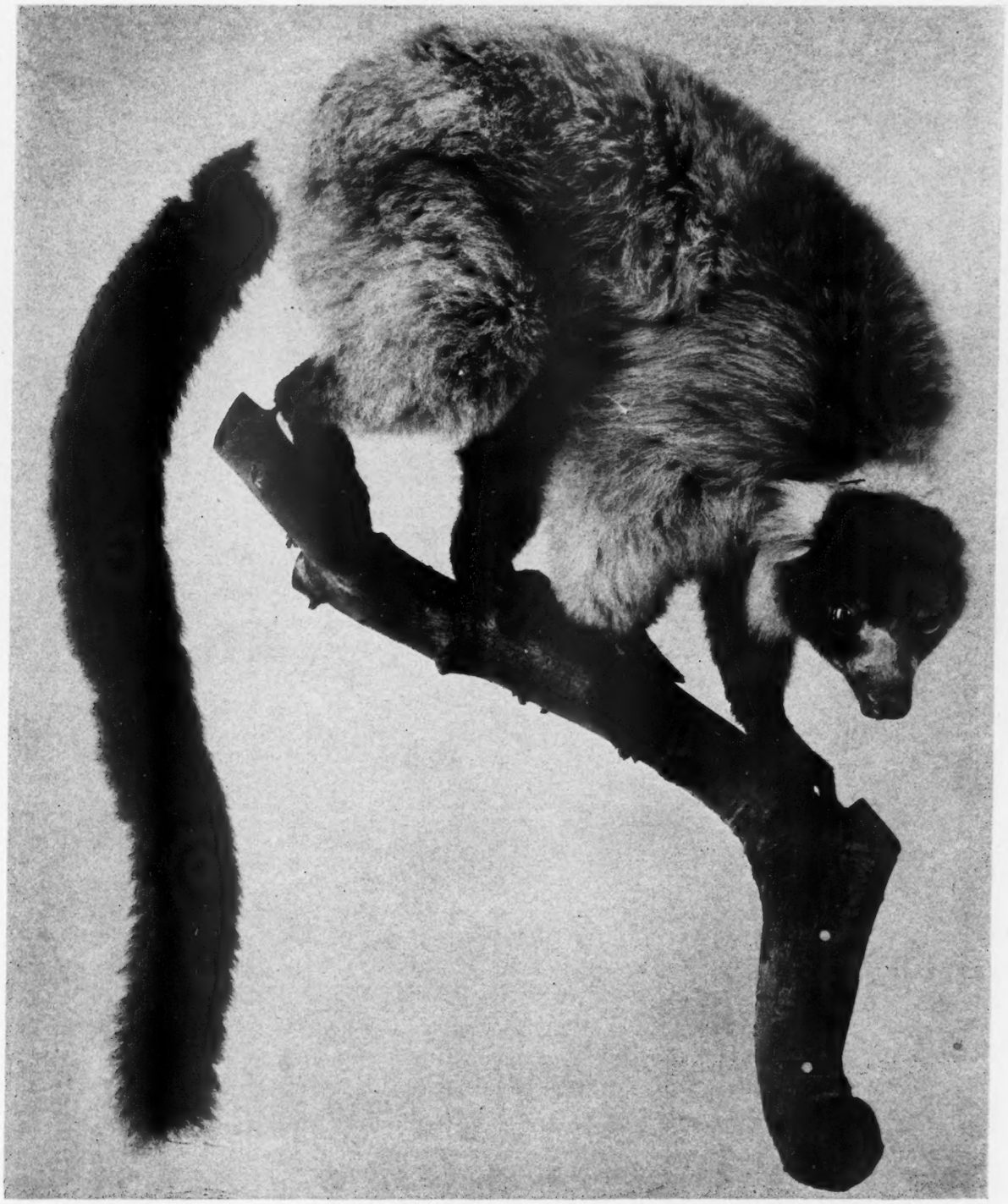

FIG. C. Varied lemur (*Lemur variegatus*, Kerr). (By permission of the American Museum of Natural History, New York.)

anomalies should often be associated with renal agenesis. Indeed, many authors have called attention to the frequent coincidence of congenital anomalies of the genitalia and anomalies of the urinary tract. Hinman, in a

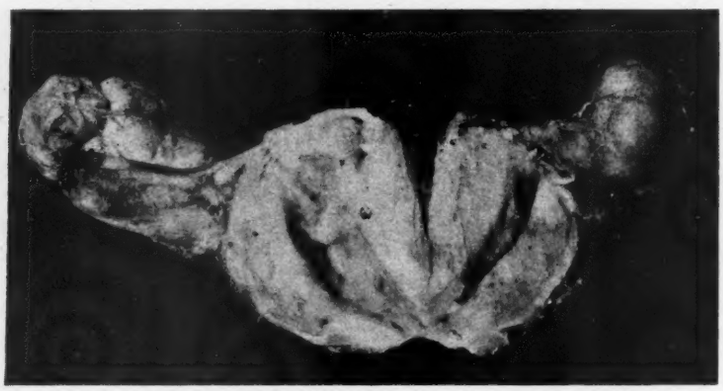

FIG. 13. CASE V, J. F. Uterus bicornis unicollis. Both halves of the uterus are split open and are shown to be connected by nothing more than the supravaginal portion of the cervix.

critical review of congenital bilateral absence of the kidneys, states that renal agenesia is usually associated with gross malformation of other organs. In the female, the derivatives of the Müllerian ducts are most often affected.

Unilateral renal agenesis is frequently associated with uterus unicollis, but it occurs in association with symmetrical uterine anomalies as well as with unilateral defects. One of my own cases (Case V) showed uterus bicornis unicollis associated with absence of the right kidney. (Figs. 13 and 14.)

A study of the literature shows that in many cases of uterine or other genital malformation there has been no attempt at adequate urological examination. Conversely, in cases of abnormalities of the urinary tract there is very often a lack of thorough investigation of the genital system. It should be regarded as axiomatic that in all cases in which the genital tract is anomalous the urinary tract must be studied thoroughly.

INCIDENCE

Individual reports covering one or more cases usually advance our knowledge of uterine malformations but do not give a true index of the frequency of these anomalies. Even compilations from the literature fall short of the mark in giving a true picture of the incidence. Thus, in a review of the literature from 1922 to July 1936, Beaver and Abbott found reports of 246 cases of malformations of the uterus. They readily admit, however, that because of the voluminous literature, other cases may have been overlooked.

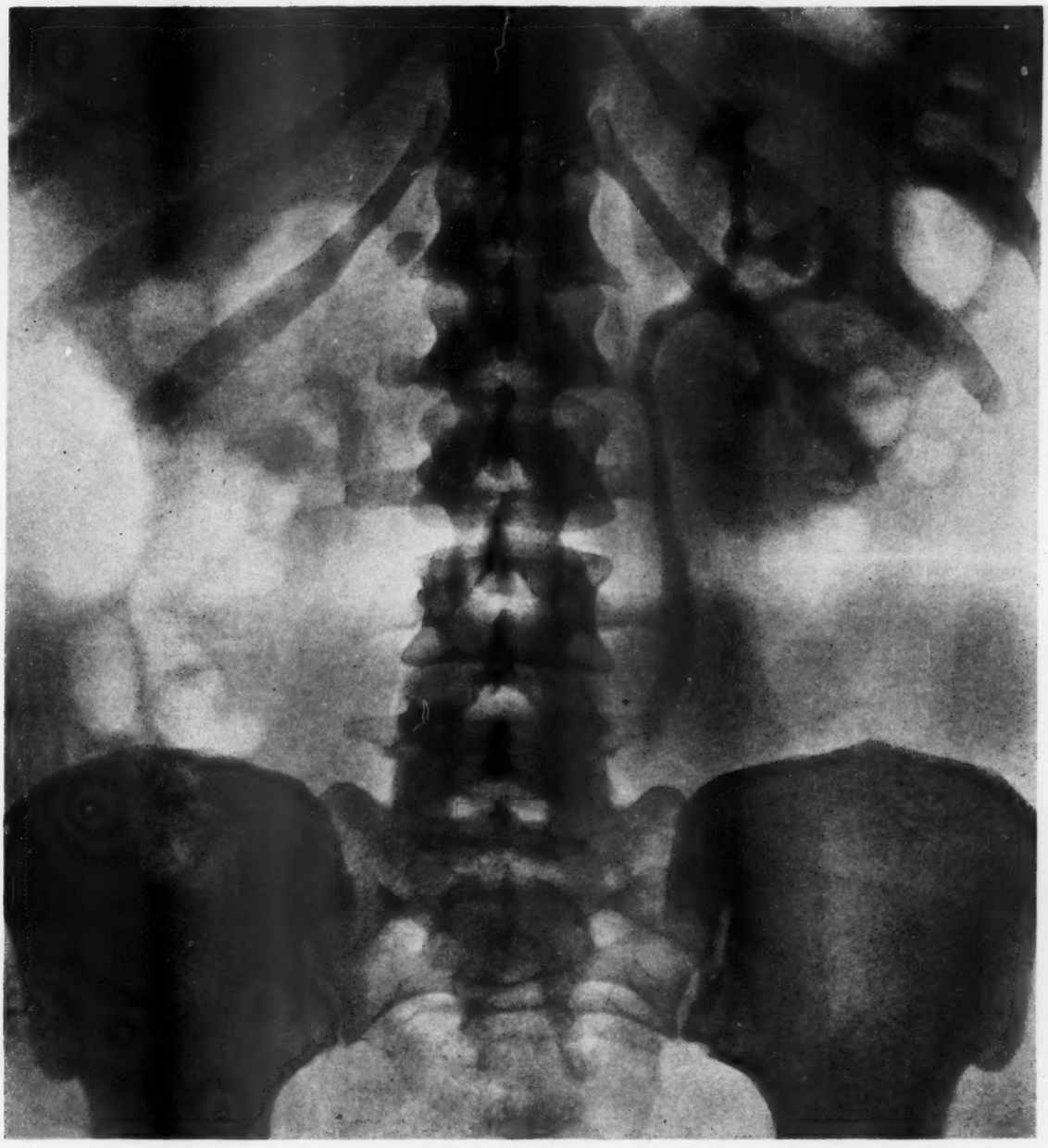

FIG. 14. CASE V, J. F. Pyelo-ureterogram after retrograde injection of hippuran solution into the left ureter. The right kidney was absent.

In addition, many cases are discovered but remain unreported or are not reported in adequate detail. This fact becomes quite evident to anyone who reads the published discussions that follow the presentation of almost any paper on uterine anomalies. Often such anomalies are given but casual mention. Moreover, as Findley has remarked, one is impressed by the frequency with which anomalies remain unrecognized even in the event of parturition. Many malformations are first discovered at laparotomy or at autopsy.

Considering the fact that many cases of uterine malformation are observed only at autopsy or accidentally during operation, and that other cases are discovered only in the event of an abnormal occurrence during pregnancy and labor, it is evident that a large number of cases must remain unsuspected and undiscovered. Probably the closest approach to the true incidence of uterine anomalies is to be found in carefully kept hospital records covering a period of years. Here, too, the aforementioned factors, as well as the efficiency of the medical staff, must be taken into consideration. One of the most significant reports of this type was published by Smith on the basis of statistics gathered at the New York Lying-In Hospital during a period of thirty and one-half years (January 1899 to July 1930). During this period thirty-five cases of double uterus were recorded; nineteen of these were observed by Smith personally. Smith was astonished to note that all types of double uterus had occurred once in 1,458 cases during the five and one-half years of personal observation, whereas in the records of 114,243 consecutive patients examined during the previous twenty-five years double uterus had been recorded once in 7,040 cases. It was inferred that some cases were not recognized or had not been recorded. It is more probable that better understanding of uterine anomalies and improved diagnosis may account for the apparent increase in incidence. Smith observed that foreign-born patients show a greater tendency to uterine anomaly than do women of so-called native American lineage.

Other hospital data since reported give valuable information. In Germany, Pfleiderer reported that during a period of twenty years ninety-three instances of genital anomaly were observed at the Tübingen Frauenklinik. There were fourteen instances of rudimentary solid uterus with solid vagina, six of uterus unicornis with rudimentary horn (more accurately classified as uterus bicornis uno latere rudimentarius), fifteen of uterus bicornis bicollis with double or single vagina, fifteen of uterus bicornis unicollis, sixteen of uterus septus with double or single vagina, and twenty-seven of uterus arcuatus.

This may be contrasted with the series of seventeen cases studied at necropsy by Masson and Kaump. These authors found three cases of uterus didelphys, four of uterus duplex and septate vagina, three of uterus rudimentarius solidus duplex with absence of vagina, two of absence of one

fallopian tube and ovary, and one case each of uterus unicornis, abnormal insertion of the fallopian tubes, hemihypoplasia of uterus, rudimentary uterus with atresia of the vagina, and atresia of a fallopian tube.

Citing statistics gathered from the registers of the Gynecological Institute of the Kyoto Imperial Institute, Kimura reported the frequency of uterus bicornis as 0.141 per cent. In other words, fifty-two out of 36,785 out-patients showed this type of anomaly during a five-year period preceding 1930. Cases of uterus arcuatus were not considered.

In their report on pregnancy in uterus duplex, Acosta-Sison and Katigbak stated that of the 68,682 maternity cases admitted to the Philippine General Hospital from 1912 to 1937, only three cases of bicornate uterus were noted. Falls' statistics (1939) with regard to the incidence of uterus arcuatus have already been cited.

That uterine anomalies are not as infrequent as might be imagined is evident in an estimate cited by recent writers (Taylor, Eisaman). It is stated that lack of fusion of the Müllerian ducts, either complete or incomplete, occurs once in about 15,000 obstetric, and about once in 2,000 gynecologic cases. From this estimate it is evident that even a specialist may see few cases in a lifetime of medical practice.

Other writers believe that the incidence of anomalies is much higher than such statistics indicate. Moore, for example, is of the opinion that the incidence of congenital anomalies in the female genitalia is probably much higher than the imperfect and random records would indicate. From private records, Moore arrives at the conclusion that one in five or six hundred women present some definite congenital deviation from the normal in the generative tract.

SYMPTOMS ASSOCIATED WITH GENITAL ANOMALIES

As has already been indicated, many women with malformation of the uterus may go through their span of life without any signs attributable to their abnormality. Thus, the symptoms of double uterus may be negligible. Conversely, deformities sometimes take on great importance and become of major moment not only with respect to their sex lives, but also, on occasion, with respect to their very existence.

Prior to pregnancy, the symptoms caused by double uterus may be slight, but menstrual disorders are encountered quite frequently and occasionally there may be difficulty in coitus. Menstrual discharges usually come from both uteri simultaneously, but may also come from one uterus at a time. According to Bainbridge, with uterus duplex, menstruation may take place every two weeks, first from one compartment of the organ, then from the other, each menstruation lasting two or three days. The patient loses in one month only about as much blood as during a normal menstrual period.

Dysmenorrhea, often quite severe, is a complaint commonly associated with bifid uterus. According to Miller, dysmenorrhea occurs in about 20.3 per cent of the cases and is an important diagnostic aid. Menorrhagia is

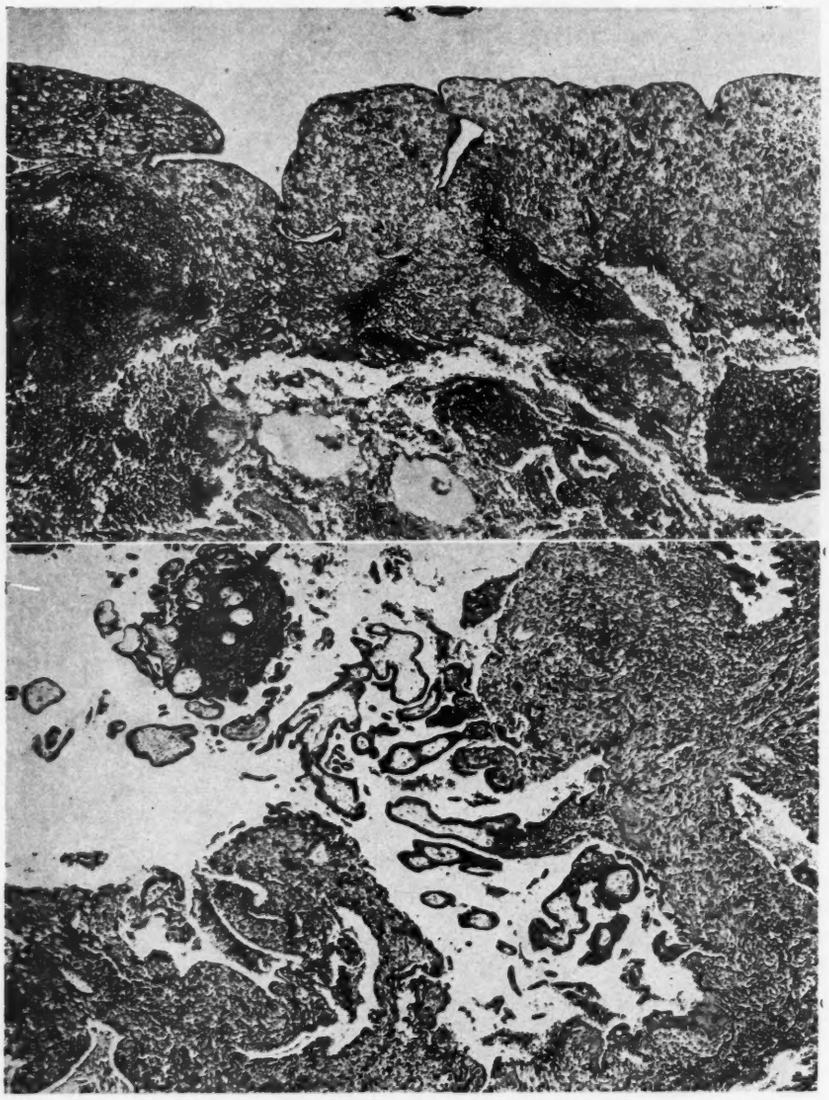

FIG. 15.

FIG. .16

FIG. 15. CASE VI, S. C. Cast expelled from right non-pregnant uterus consists of decidual tissue only.

FIG. 16. CASE VI, S. C. Tissue obtained by curettage of left-sided uterus consists of chorionic villi. (Compare with Figure 15.)

often severe and frequently makes operative interference necessary (Snyder). In any instance of uterine anomaly in which the area of the endometrium is increased, whether as the result of bicornate uterus or septate uterus, there is a definite tendency to menorrhagia (Masson and Rieniets).

During pregnancy in one horn of a bicornate uterus, the non-gravid horn usually forms a decidua. In one of my cases, the patient expelled a decidual cast from the non-pregnant uterus and five days later expelled the

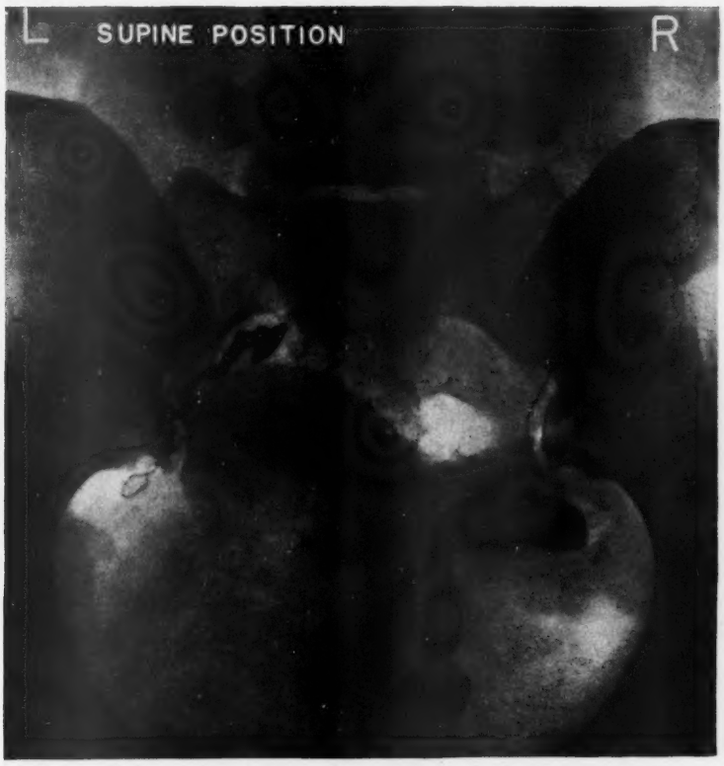

FIG. 17. CASE VI, S. C. Uterus duplex bicornis bicollis, vagina septa: occlusion of right fallopian tube. Uterosalpingogram, combined method, 800 cc. of carbon dioxide, followed by 5 cc. of opaque medium in the right uterus and 7 cc. in the left uterus. The right uterus is well outlined. It is filled with opaque medium except for the region of the right cornu which is occupied by a small quantity of trapped gas (reader's right). Right tube is occluded and did not permit trapped gas to leave uterine cavity. Left uterus well outlined and filled throughout its entire extent with opaque medium. Left cornual sphincter evident. Left tube curled on itself was occluded but became patent after introduction of gas under pressure of 190 mm. Opaque medium is seen exuding from left ostium abdominale.

entire ovum from the pregnant uterus. Sometimes the non-pregnant horn may continue to menstruate (Bainbridge). (Figs. 15, 16, 17 and 18.) Findley suggests that this fact indicates the independence of the functions of the two horns. Schauffler believes that the decidua in the non-pregnant horn is subject to the same hormonal influences which control the actual pregnancy. Hence the non-gravid uterus may be expected not to bleed normally

at any time during the pregnancy. Thus, when irregular bleeding does occur, this writer believes that it should be considered in connection with damage to the chorionic tissue of the pregnancy itself and should be treated by

FIG. 18. CASE VI, S. C. Schematic drawing of Figure 17.

procedures indicated in threatened abortion. Bleeding occurred three times in fifteen successful pregnancies in Schauffler's series of patients, and it occurred in all those who miscarried.

Taylor states that in a patient with duplication of the uterus bleeding during gestation may be due to the passage of a decidual cast and need not necessarily be indicative of threatened abortion.

Occasionally the decidual membrane may be expelled before parturition occurs from the gravid uterus, thereby simulating abortion. Meanwhile pregnancy continues undisturbed in the other horn. Unless the presence of double uterus is recognized, the surgeon may curette away the living ovum in the belief that an abortion has occurred (DeLee and Greenhill). Spontaneous abortions are not infrequent in such cases and in septic abortions both uteri should be emptied (Shirley and Cogswell).

DOUBLE UTERUS AND CONCEPTION

Fertility and frequency of conception in the presence of double uterus are not greatly affected (Masson and Kaump, Campbell, Meaker). On the

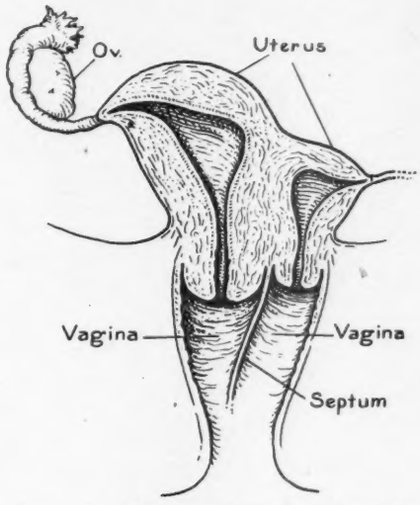

FIG. 19. CASE VII, M. G. Schematic drawing of uterus duplex, bicornis, bicollis, vagina septa. The right uterus is the larger. The septum is directed from left to right, narrowing the right ostium of the vagina.

contrary, double uterus seems to favor conception (Luikart). "In fact," says Schauffler, "one is almost tempted to infer that fertility and the sex urge are distributed among these women in the same generous ratio as their organic sex equipment."

SUPERFETATION

In women with double uterus, the proportion of twins is definitely greater than in normal women. Berkeley, Bonney and MacLeod point out that with a normal single uterus, the ratio of twins is 1 in 89, whereas with double uterus it is 1 in 12. Naturally, this brings up the question of superfetation. Students of the subject, like Findley and Blair-Bell, believe that duplication of the uterus presents frequent examples of what may properly be regarded as superfetation.

Nevertheless, one must not overlook the fact that some anomalies of the uterus are associated with sterility and it is known that some patients with double uterus may have difficulty in becoming pregnant. Sterility, however, may be due to a mechanical obstacle to conception. (Fig. 19.)

Kelly and his collaborators, when grouping the factors responsible for sterility, stated that 11 per cent of cases of sterility are attributable to developmental anomalies of the vagina, uterus, tubes or ovaries (including infantile pelvic organs).

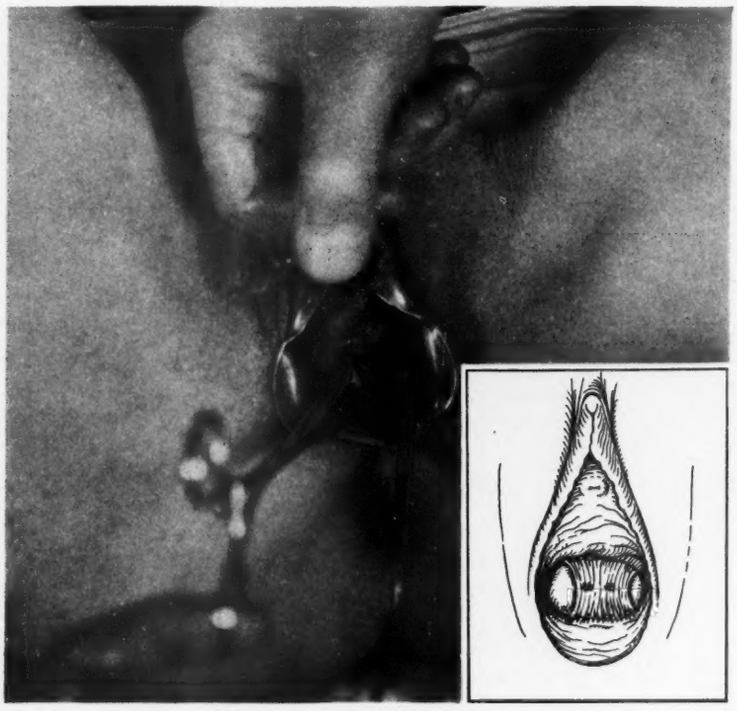

FIG. 20. CASE VIII, E. B. A photograph of the wide thick septum of the vagina. A Mathieu speculum has been introduced into the vagina. The lateral edges of the septum have been pushed to the midline to expose the lateral walls of the cervix. Tenaculum forceps have been applied on each side of the cervix. Diagnosis: Uterus unicornis; uterus biforis; vagina septa. *Insert:* Schematic drawing of the wide thick septum of the vagina covering the cervix. After excision of the septum a septate cervical canal was seen (uterus biforis).

MANAGEMENT OF PREGNANCY AND LABOR IN DOUBLE UTERUS

The statement is frequently made that the management of pregnancy and labor in cases of double uterus should not differ from the management of normal cases, except in the event of complications. Taylor, on the contrary, believes that the condition is itself a complication of pregnancy and should so be regarded. Unfortunately, a large proportion of uterine malformations do not become manifest until complications occur or until a history of previous interrupted pregnancies leads to thorough investigation. Then, too, as Rosenbloom reminds us, the literature contains many reports

of full term pregnancies in double uteri and frequently these pregnancies have terminated spontaneously with the birth of living babies.

In my experience, operative interference was required in two cases.

FIG. 21. CASE VIII, E. B. Uterosalpingogram shows well developed uterus unicornis and patent left fallopian tube. Note wide dissemination of opaque medium in peritoneal cavity. Aplasia of right cornu and right fallopian tube.

Each was delivered by cesarean section twice (healthy children obtained); one had five incomplete abortions which required curettage once.

It is well established through careful studies such as those of Smith that in women with congenital uterine malformations there is a higher proportion of fetal and infant deaths, a lower percentage of viable babies and an increased tendency toward fetal abnormalities. (Figs. 20 to 24.) Puddicombe also notes that deformities of the fetus, such as scoliosis, talipes equinus and polydactylism are not infrequent. Similarly, in his contribution to the pathology of arcuate and bicornate uterus, Ernst finds that in addition to unfavorable position, poor contraction and early separation of the placenta, unusual conditions affecting the fetus are relatively common. These include amputations and developmental defects. All possible malformations of the placenta also occur and are attributable to faulty implantation. Ernst notes that hyperemesis and preeclampsia are common.

UTERINE ANOMALIES AND ABORTION

Patients with malformation of the uterus show a markedly increased tendency to abortion (DeLee and Greenhill, Falls (1933), Smith). In his

series of 135 cases, Findley reported the incidence of abortion as 39.6 per cent. In Schauffler's series of eleven cases of double uterus with pregnancy there were thirty-two pregnancies of which seventeen aborted or miscarried,

FIG. 22. CASE VIII, E. B. Vaginogram shows that the opaque medium has distributed itself around the septum. The upper portion of the vagina is wide. Filling defect seen in the lower portion of the vagina is produced by the septum. Salpingogram of left tube is shown. Salpingogram shows that the right fallopian tube is absent. Diagnosis: Uterus unicornis; uterus biforis; vagina septa.

a proportion of 53 per cent. Taylor estimates that the incidence of abortion in cases of uterine anomaly is about 25 per cent. However, he concedes that since some instances of abortion may be due to unrecognized anomaly, the higher figures may be more accurate.

A policy of watchful waiting is usually advocated in patients with uterine malformation. This should not preclude the utilization of any and

FIG. 23. CASE VIII, E. B. Roentgenogram of pelvis showing fetus of 234 days' gestation.

FIG. 24. CASE VIII, E. B. Uterosalpingogram after peruterine injection of opaque medium of dead fetus of Case VIII showing cordiform uterine cavity. Both fallopian tubes are well outlined.

all immediate and positive measures that will bring the pregnancy to a successful termination.

The frequency with which pregnancy in the rudimentary horn of a double uterus is mentioned in the literature is a definite indication of the danger of this occurrence. When the canal of a rudimentary horn communicates with the vagina, fertilization of the ovum may occur by the natural route. Very often, however, the rudimentary horn has no connection with the uterine cavity and pregnancy in the horn is effected by external migration of the spermatozoon or a similar migration of a fertilized ovum from the normal side (Kelly). In either case the abnormal structure of the rudimentary horn constitutes a most serious complication. As remarked by Cherry, the musculature of the maldeveloped portion usually does not react as does the fully developed uterus; it is unable to stand the strain of the growing fetus. The result is a condition similar to tubal pregnancy. Ectopic pregnancy, with subsequent rupture and hemorrhage, was reported over forty times in the 246 cases of uterine malformation reviewed by Beaver and Abbott.

According to Falls (1933), the degree of fetal development attainable before rupture of the rudimentary horn will depend on the capacity of the horn to hypertrophy and dilate to meet the needs of the growing embryo. Rupture in a rudimentary horn is prone to occur somewhat later than in tubal ectopic pregnancy and because of this fact the associated concealed hemorrhage may be all the more severe. When rupture does occur, it usually produces shock and anemia. This author is of the opinion that the whole clinical aspect simulates the interstitial type of ectopic pregnancy rather than the tubal or ovarian type.

It is not always easy to diagnose pregnancy in a rudimentary uterine horn. Palpation will sometimes show the more normal horn at one side to be of usual or slightly softened consistency. Occasionally signs associated with bicornate uterus, such as double septate vagina or double cervix will provide a clue that uterine malformation is present and so help to differentiate the condition from other forms of ectopic pregnancy. However, as Kerr has so aptly observed, it is often of no very great practical importance which condition is diagnosed, except for the satisfaction of a correct and exact diagnosis, because surgical treatment should be undertaken immediately.

The great danger, as Kerr emphasizes, lies in mistaking a gravid rudimentary horn for a myoma complicating normal uterine pregnancy. In the event of such an error, if pregnancy is permitted to continue in the hope that the myoma may be pulled up out of the pelvis (as often occurs), the patient's life may be endangered by rupture of the gravid horn.

It is generally accepted that the treatment for pregnancy in a rudimentary horn, once diagnosed, is immediate laparotomy and prompt removal of the gravid uterus (Acosta-Sison and Katigbak, Beck, Blair-Bell,

Falls (1933), Kelly). Stander has observed that the mortality statistics for this condition have become much more favorable because of greater accuracy of diagnosis and more frequent recourse to surgical intervention.

In cases with double uterus it is not unusual for pregnancy to go to term, and delivery often occurs without marked difficulty, but the proportion of patients with uterine malformations who go to term is considerably less than in the case of women with normal uteri. The frequency with which normal delivery occurs will depend to a large extent upon the severity of the malformation. For example, only a small proportion of pregnancies in uterus didelphys go to term (Moncure). In Miller's series, only 42 per cent of such cases (occurring in twenty-eight of the total sixty-seven pregnancies) had a normal spontaneous delivery at term. Abortion or interruption of pregnancy before the period of viability were the chief causes for this low percentage.

UTERINE ANOMALIES AND COMPLICATIONS IN PREGNANCY

A high ratio of difficult or complicated labor is to be expected in women with uterine malformations. Labor is often normal, but as is pointed out by DeLee and Greenhill, complications such as the following have been observed: weak pains; atony in the third stage with postpartum hemorrhage; adherent placenta; prolapse and incarceration of the non-pregnant portion of the uterus under the pregnant portion. The cervix of the non-pregnant uterus may be forced down to the vulva with the head. The uterus may rupture because of poor musculature. The septum in the vagina may form an obstruction.

In his report on uterus didelphys, Miller pointed out that 40 per cent of women with this anomaly have complicated deliveries at term. He listed the complicating factors in the following order: enlarged non-gravid uterus; vaginal septum; uterine inertia; tetanically contracted uterus; retention complications, and eclampsia. Retention complications were found in 17 per cent of all cases.

Other factors may complicate the picture. Irregularity of the fetal heart is not uncommon, not only during labor (Falls 1928), but also in the later months of pregnancy (Puddicombe). Manual removal of the placenta is often necessary, and even in the event of spontaneous delivery the placenta often fails to separate (Smith). Postpartum hemorrhage is likewise a frequent complication and its management is often difficult. Less serious complications of labor are very frequent (Rhemann).

In discussing pregnancy and the double uterus, Taylor warned that when these patients come to labor it is well to remember that the cervix may be poorly formed and that the musculature of the uterus may be irregular, poorly vascularized, thin, and irregularly disposed, while the stroma may be inadequate.

The septate uterus, according to DeLee and Greenhill, may cause breech and transverse positions, weak pains, postpartum atony, rigidity of the cervix, adherent placenta, and, if the septum is in the cervix (uterus biforis), obstruction to delivery.

FIG. 25. CASE IX, A. S. Roentgenogram of uterus duplex, bicollis. Vagina septa with defect in the septum between the uteri. A sound introduced into each cervix crossed through the defect in the septum and entered the opposite uterus.

As Falls has stated (1939), the course of labor in patients with the more common anomaly, uterus arcuatus, differs markedly in individual cases. Thus, in a small proportion of cases labor takes onset from a few weeks to two or three months in advance of the normal time, while in a somewhat larger group there is a definite tendency to postmaturity, varying from a few days to a week or more. In many cases this postmaturity may be due to failure of the presenting part to engage normally at term and this in turn is attributable to obliquely transverse presentation of the fetus and to deficiency in the development of the uterine muscle. Induction of labor is often necessary and the response may be weak and unsatisfactory. When

labor starts spontaneously, the pains are often weak and irregular and a slow course of labor may be expected.

In a series of patients with uterus arcuatus studied by Falls, the

FIG. 26. CASE IX, A. S. Roentgenogram of uterus duplex, bicollis. Vagina septa with defect in septum. The cannulas crossed in the defect in the septum. There was an intravasation of the uterine blood vessels. Opaque medium has entered the uterine blood vessels, presumably because the septum was thin and the vessels were distended.

incidence of postpartum hemorrhage was twice that observed in ordinary cases. A maternal mortality of 1.9 per cent clearly indicates that the condition should be regarded seriously as a complication of pregnancy and labor.

In the management of pregnancy complicated by double uterus, it should be remembered that the relatively thin uterine wall presents a constant threat of rupture if labor is long or even if it is brief and difficult (Gramling). According to Puddicombe, if rupture does occur, it generally takes place during the last month of pregnancy or during labor. In his

opinion, the uneven distribution of uterine muscle and misdirected forces serve to protract labor and weaken the uterine wall, thereby increasing the danger of rupture. More rarely, the non-gravid horn may obstruct the

FIG. 27. CASE IX, A. S. Vaginogram of septate vagina. Note opaque medium remaining in the peritoneal cavity from previous uterosalpingogram. (See Figure 26.)

passage of the child, causing rupture of the pregnant horn. This occurred in the case reported by Hall.

According to Schumann, obstruction of the non-gravid horn is fairly common since this structure enlarges concomitantly with but not to the same degree as the pregnant horn. The non-pregnant horn may encroach directly upon the birth canal and close it off from the descending presenting part, or it may act to displace the axis of the pregnant uterus from that of the pelvic canal and thereby lead to severe dystocia. Berkeley, Bonney and MacLeod believe that if the non-gravid horn remains below the head of the child and causes obstruction, cesarean section is the correct procedure. In a few instances, an obstructing horn which filled the pelvic cavity has been pushed up. It has been found by experience that it is never pulled up spontaneously during labor. Frequently the non-pregnant uterus contributes to fundic irregularities that are responsible for malposition of the fetus. However, Schauffler believes that these complications are recognizable and usually may be circumvented.

FIG. 28. CASE IX, A. S. Uterus duplex bicornis, bicollis; fetus aged 201 days in utero, breech presentation. The body of the fetus is in one uterus and the lower extremities have entered the other uterus through the defect in the septum. This was subsequently confirmed by cesarean section. This patient conceived after uterosalpingography.

FIG. 29. CASE IX, A. S. Roentgenogram of same patient as Figure 25. The fetus in utero is of 273 days' gestation; breech presentation. The body of the fetus is in one uterus and the feet are still in the other uterus.

As is to be expected, in patients with double uterus there is a greatly increased frequency of breech and transverse presentation (Schumann, Smith). In my two cases, one patient (Case IX) had breech presentation at

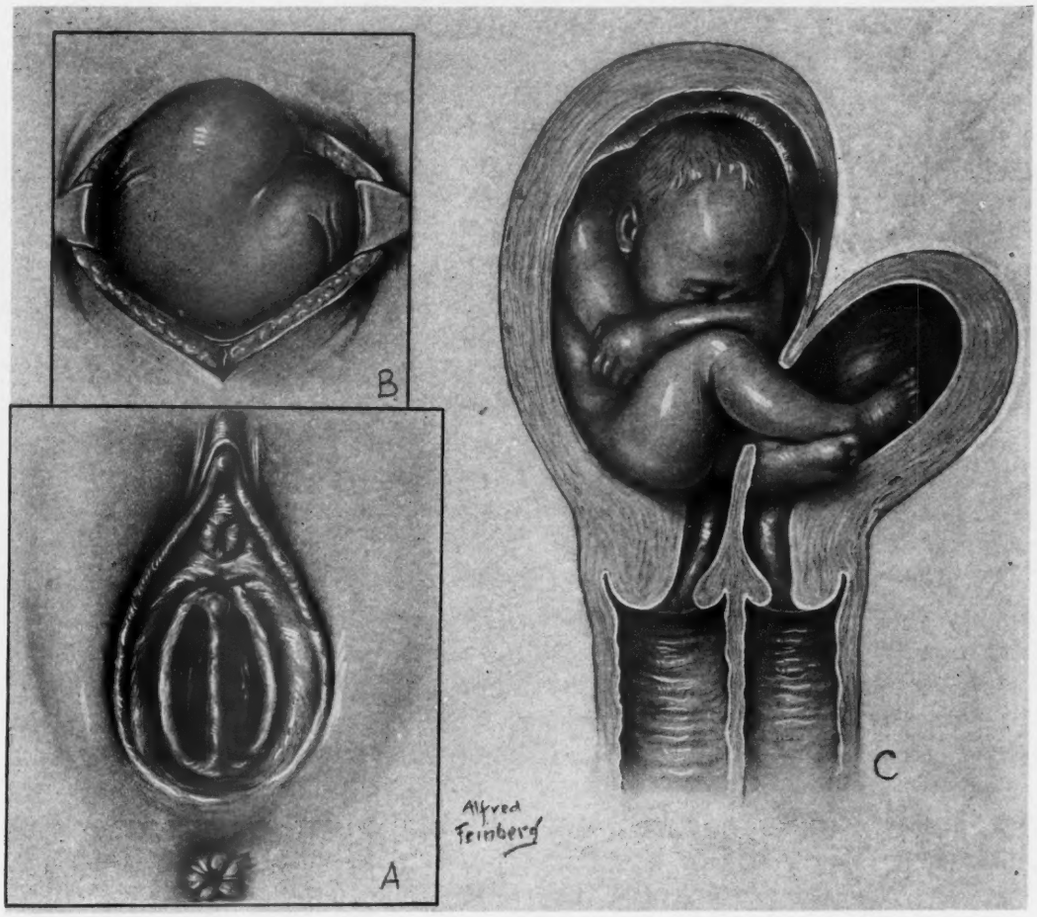

FIG. 30. CASE IX, A. S. Schematic drawing of genitalia of Case IX. A, Septum in vagina; B, anterior view of two uteri during cesarean section; C, coronal section showing both uteri. The entire body of the fetus is in the right uterus and the feet are in the left uterus. The baby had metatarsus varus. Note that during operation the appearance of the septum corroborated the findings of Figures 25 and 26.

each delivery. In Schauffler's series, of fifteen deliveries, four were breech presentations. In all the result was satisfactory. In the series of cases reported by Falls in 1939, breech presentation occurred fifteen times in the 134 patients delivered from below. This ratio (11 per cent) is in marked contrast to the general incidence of breech presentation (3.5 per cent). The babies in this group showed an uncorrected mortality of 13 per cent as against a general mortality in breech presentation of 7 per cent. Falls believes that the general mortality in breech presentation is such that it

is entirely unjustifiable to endanger the lives of these babies when the possibility of safe delivery from below is seriously jeopardized by dry labor, prolapsed cord, and inefficient uterine contractions.

A purely mechanical effect may result in the transverse position of a fetus with the head in one cavity of a uterus bicornis septus, the feet in another. (Figs. 25 to 30.) Sometimes the placenta may be on one side of a septate uterus and the fetus in the other (Frank). In one case reported by Berkeley, Bonney and MacLeod, roentgen examination revealed that the child lay partly in one horn and partly in the other.

UTERINE ANOMALIES AND CESAREAN SECTION

As is already evident, the indications for cesarean section occur with much greater frequency in patients with uterine malformation. Because of malposition, dystocia or both, the more extreme forms of bicornate uterus very frequently present an indication for cesarean section. It should be noted, however, that many obstetricians, like Shirley and Cogswell and Galloway, believe that such maldevelopments are not absolute indications for cesarean section. They are of the opinion that if pregnancy occurs and remains uncomplicated, the patient should be permitted to have a test of labor.

There are definite conditions under which cesarean section remains the most efficient and humane method of dealing with the problem and circumventing many complications. Many agree, for example, that incarceration of a non-gravid horn is usually an indication for the cesarean operation (Findley, Hardy, Moore). If the incarceration is accompanied by a breech presentation at term, it is an absolute indication for this method of delivery, according to Taylor.

In these cases the possibility of rupture of the uterus during labor is an important indication for cesarean section. Sometimes this operation is necessary because of persistent transverse presentation (Titus).

According to Smith the tendency to contracted pelvis also accounts for an increased incidence of cesarean section. In Falls' (1939) cases, in which 13.5 per cent of the patients were delivered by cesarean section, operative intervention was indicated chiefly by the combinations of contracted pelvis and arcuate uterus. Falls found that the results of conservatism in the management of these cases has been so disappointing as to warrant a more radical attitude. Operative intervention was elected especially in those cases in which premature rupture of the membranes complicated the problem of delivery, because long drawn out labor results in intrauterine infection and infection markedly increases the dangers of cesarean section if this operation becomes necessary. Marked irregularity or rapidity of the heart tones is another indication for termination of labor by cesarean section, but if the heart tones are normal and labor is progressing normally, even if

somewhat slowly, a conservative attitude is maintained and labor is allowed to go to spontaneous termination provided alarming symptoms on the part of the baby do not develop.

Schauffler recommends that surgical equipment be kept immediately available at the delivery of patients with uterine malformation. Such equipment may be necessary not only for the treatment of vaginal and cervical anomalies but also for possible cesarean section.

DIAGNOSIS OF UTERINE ANOMALIES

In only a comparatively small proportion of cases does the physician have the opportunity to discover a uterine malformation before the picture is complicated by pregnancy. In a large proportion of cases, anomaly is not suspected until difficulties arise during pregnancy or labor. In other instances the abnormality may be discovered during an examination for irrelevant symptoms requiring very thorough physical examination. Persistent or periodic pain may cause the patient to seek medical advice. Anspach states that where the uterus is double but the two horns are not equally developed, especially if one horn is atretic, the condition is more likely to become evident after puberty, when pain and other symptoms of gynatresia may appear.

In rare instances dyspareunia may be the chief complaint (Taylor). In several of my cases, sterility was the complaint that led the patient to seek medical advice.

A careful history will often elicit diagnostically valuable information. Definite menstrual irregularity, especially delayed menstruation or semimonthly flow, is a helpful hint and the occurrence of dysmenorrhea is suggestive. A history of interrupted pregnancies or abortions should also suggest the possibility of malformation of the uterus. (See Case VI.)

Some years ago Schwarz stated that women with a double uterus have unusually broad pelves. This observation has been confirmed (Schumann) but cannot be considered a dependable sign. The finding of a vaginal anomaly, such as a septum or other malformation, should at once raise the question of other abnormalities further up the genital tract. Examination of the cervix will often give further clues, a double cervix being indicative of uterus didelphys or uterus bicornis bicollis. The insertion of a sound, while contraindicated if pregnancy is suspected or present, will often give more positive information regarding the condition within the uterus itself. Caution should be exercised in passing metallic sounds to avoid injury or even perforation of the uterine wall. (Figs. 31, 32 and 33.)

Simple abdominovaginal palpation may enable the physician to feel a broadening or an indentation of the fundus. However, Schauffler is of the opinion that simple bimanual examination, in the absence of other suggestive signs, is not likely to clarify the situation. During pregnancy, palpa-

tion is more likely to give useful information that will enable the physician to diagnose and differentiate a uterine malformation from tumors or other lesions. Usually the uterus will appear larger on one side than the other,

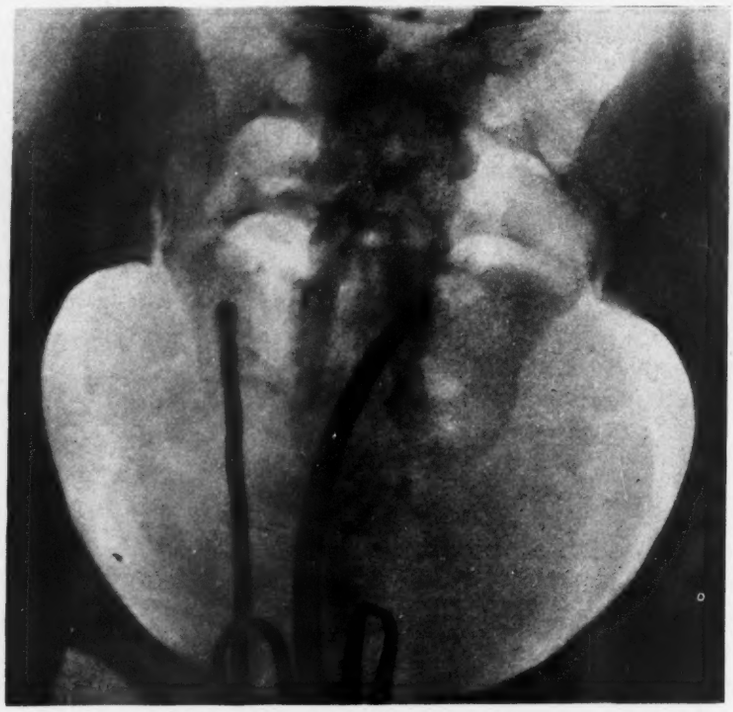

FIG. 31. CASE X, E. J. Uterus didelphys. Roentgenogram after introduction of a sound into each uterus.

and frequently the development of the body of the uterus will be eccentric (Falls 1939).

Uterosalpingography. It has long been my opinion that uterosalpingography is one of the most valuable means available to the gynecologist and obstetrician for the diagnosis of uterine malformations. I have devoted many years of study to this means of diagnosis and emphasize especially the safety of the procedure. It is gratifying to observe that other investigators also have found this method of great diagnostic value.

Since it can be used with a degree of safety, uterosalpingography should be a routine procedure in all cases in which anomaly is suspected. Properly performed, with necessary precautions, uterosalpingography provides an excellent means for the roentgen visualization of the internal genital organs through the use of opaque media such as iodized oils, or the newer and more readily absorbable opaque media.

In many gynecological disturbances, such as obstruction and diseases of the tubes, tumors of the uterus and uterine malformations, uterosalpingog-

FIG. 32. CASE X, E. J. Uterosalpingogram shows two distinctly separate uteri with one fallopian tube in each. Observe opaque medium in a sinus connecting the supravaginal portion of both cervices.

FIG. 33. CASE X, E. J. Vaginogram of septate vagina. Note recesses in each vagina.

raphy gives exact information that can be obtained by no other means. Even when diagnosis of a gynecological condition can be made without the aid of uterosalpingography, this procedure adds a definite element of exactness as to the type of malformation or other pathologic conditions.

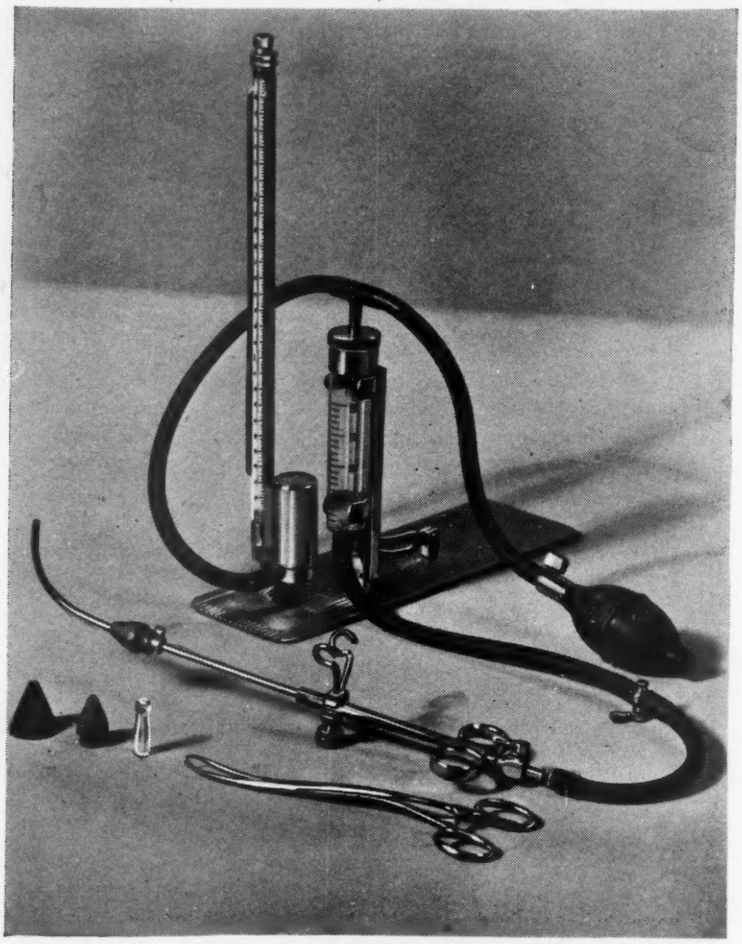

FIG. 34. Jarcho Pressometer for introduction of opaque media into the female genital organs in doing uterosalpingography. It is used also for retrograde pyelography. The above photograph illustrates the Jarcho Pressometer complete. Below the instrument are shown the rubber cone tip, the rubber acorn tip, the pyelographic glass catheter adapter and Jarcho tenaculum.

Uterosalpingography is contraindicated in the presence of heart disease, gonorrhea and acute tubal inflammation, malignant growths of the uterus (because of the danger of carrying cancer cells into the peritoneal cavity), menstruation and profuse bleeding and pregnancy.

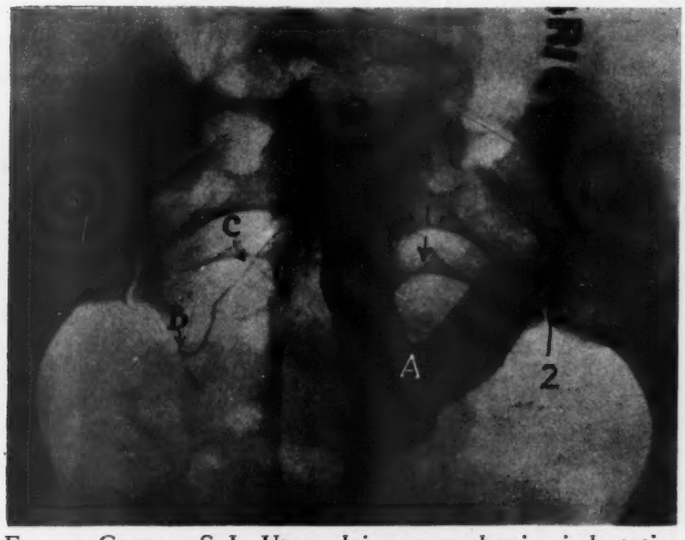

FIG. 35. CASE XI, S. L. Uterosalpingogram showing indentation in the uterine shadow produced by a fibroid tumor which simulates uterus bicornis. The left tube is patent. The right tube is occluded at the cornual end. This defect was produced by a small fibroid in the right cornu, as indicated by arrow No. 2. (From Julius Jarcho, in *Surg., Gynec. & Obst.*, 46: 752, 1928. By permission of publishers.)

FIG. 36. CASE XII, R. C. Elongation of right cornu (reader's right). Uterosalpingogram for primary sterility. The tubes were occluded and became patent. A large amount of opaque medium is exuding from the ostia abdominalia. (See also Case II.)

The Jarcho Pressometer. The author has introduced a special instrument for uterosalpingography, the pressometer. This instrument facilitates introduction of gases and opaque media into the uterine cavity and has

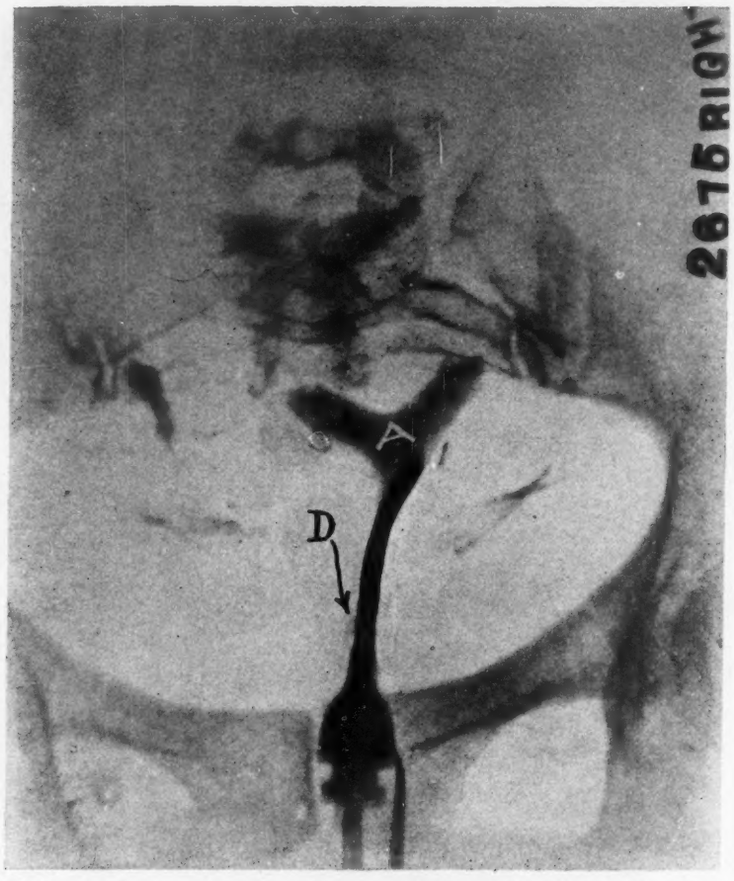

FIG. 37. CASE XIII, S. D. Uterogram of poorly developed uterus bicornis. (From Julius Jarcho, in *Surg., Gynec. & Obst.*, 46: 752, 1928. By permission of publishers.)

proved a valuable aid in diagnosing uterine malformations. The pressometer consists of reservoir equipped with a manometer by means of which the operator can measure the amount of pressure under which the opaque medium is introduced into the genitalia, as well as the quantity of medium injected. By employing the special catheter adapter the pressometer can be used for retrograde pyelography. (Fig. 34.)

Uterosalpingography does not render unnecessary the acumen of the examining physician, nor does it supplant a careful history, a thorough physical examination, and balanced judgment.

It would be superfluous to give the details of the transuterine introduction of the opaque media and the methods for taking the roentgenograms

because they have been described frequently in the literature. However, I believe that I should comment briefly on the importance of careful analysis of all uterosalpingograms and to stress the fact that the physician should not hesitate to seek the advice and cooperation of roentgenologists. In this connection, I recall a roentgenogram published in one of my papers (1928) which, upon hasty examination, might easily have led to the diagnosis of bicornate uterus. Upon closer study, however, the malformation was found to be due to pressure of a fibroid tumor on the fundus of the uterus, producing a filling defect in the uterogram, thereby simulating double uterus. (Fig. 35.)

A more accurate diagnosis made with the help of uterosalpingography is a major factor in determining whether or not a surgical procedure may be employed to correct a uterine malformation. Luikart, for example, placed great reliance upon the use of uterosalpingography to help visualize the difficulties which may be met if an attempt is made to remove a uterine septum. His paper covers the technic of removal of the septum of uterus septus and subsequent deliveries at term. It was observed in two cases that there was no disturbance of the contraction of the uterus following removal of the septa. (Figs. 36 and 37.)

SURGICAL CORRECTION OF GENITAL ANOMALIES

Procedures for the surgical correction of various uterine malformations have been reported quite frequently in the literature. Like Strassmann, Granberry and Faust, Sweet and others, I believe that in the absence of specific indications such as complicating pathological conditions, sterility, or very probable danger in the event of pregnancy, it is seldom necessary to operate merely for the sake of correcting an abnormality. Surgical measures based solely on the presence of an anomaly are seldom justified.

Over a decade ago, Smith said that the necessity for operative correction in these cases had been greatly exaggerated and I have noted that most contemporary writers maintain a conservative attitude with regard to such intervention. This attitude is apparent in Schauffler's paper. For example, he is of the opinion that elective operation for sterilization should be justified only by serious results from previous pregnancies or other pathological conditions which indicate the operation.

Some authors believe that plastic reconstruction of the uterus to form a single organ may sometimes be resorted to in the hope of a successful future pregnancy (Moore, Campbell). Often, however, the hoped-for event does not materialize even with metroplasty. Thus, Berkeley, Bonney and MacLeod reported that although they had performed such operations several times, the patients did not become pregnant. Rhemann obtained better results; the use of the Strassmann plastic operation in thirty-seven cases was followed by pregnancy in eleven patients. He states, however,

that in cases of double uterus this operation is justified only when the malformation is responsible for habitual abortion and premature labor and the patient seeks relief of these conditions. In view of the dangers and risks involved in pregnancy, Snyder believes that plastic reconstruction is a doubtful benefit. It is his view that sterilization would seem to be the preferable procedure in most cases.

The advisability of obliterating an intrauterine septum by excision or electrosurgery is questioned by Schauffler. Nonetheless, there are times when such removal becomes necessary. In Luikart's cases, for example, removal of the septa was indicated by previous miscarriages and abortions. Removal of the septum in each instance resulted in successful delivery of normal babies at term.

Removal of vaginal septa is sometimes necessary in order to obtain free drainage of uterine secretions (Snyder). In other instances, as in the case of double uterus, cervix and vagina reported by Obenour, removal of the vaginal septum eliminates the pain which sometimes accompanies sexual intercourse.

Sometimes an opportunity presents itself to improve conditions during the course of an unrelated operation, provided the condition is known, as in Eisaman's case, and the surgeon is unusually alert. In Eisaman's case, appendectomy was performed and an incidental plastic operation was also done. The component parts of a uterus bicornis with extreme lateral flexion were placed upright in a more normal position; sterility was thereby relieved.

In one of my own cases (Case x), in which there was a uterus didelphys, an attempted metroplasty failed, and hysterectomy was necessary. In that patient a branched sinus connected the supravaginal cervices.

Surgical operations in cases of uterine malformation vary widely. It is quite obvious that no fixed rule or type of operation is applicable, since the extent of malformation varies from patient to patient. Wherever possible, surgical intervention should be conservative.

CASE REPORTS

The following case histories of patients who have come under my personal observation during the past few years will serve to illustrate the various types of uterine malformation and associated symptoms that may be seen in a medical practice devoted to gynecology and obstetrics.

CASE 1. G. M., married fourteen years, age thirty-four, said her menses began at seventeen years, at intervals of twenty-eight days, with a duration of three days, and that they were painful. Her complaint was sterility.

Bimanual examination revealed two well formed vaginae and cervices. Two well developed uteri were palpable, the right being the larger. This was confirmed by uterosalpingography.

The patient had one abortion thirteen years ago at three months and was curetted because of prolonged bleeding. Curettage was followed by fever and severe abdominal pain. This illness lasted two weeks.

Diagnosis. Uterus didelphys. (See Figs. 3, 4 and 5.)

CASE II. (Fig. 6.) D. B. was twenty-four years of age and was married five and one-half years. Menses began at eleven and one-half years, and occurred every twenty-eight days, with six or seven days' duration; the flow was normal. The patient had had three confinements, April 19, 1926, May 5, 1931, and October 16, 1935.

Two weeks before the end of the last pregnancy the patient suddenly developed strong tearing pains which supervened at frequent intervals. Membranes not ruptured. Roentgenogram showed fetus lying high above crests of ilium, the head in one cornu and the legs in the other.

Under deep anesthesia external cephalic version was performed. The head was held on the brim of the pelvis for nearly an hour. Pains practically ceased. Pituitrin 0.2 cc. was given to produce uterine contractions and facilitate engagement. The patient was delivered spontaneously of a six and one-half pound living baby. This complication may occur in a uterus of arcuate type or in uteri possessing a single greatly elongated cornu. (See Case XII, Fig. 36.)

CASE III. A. S. was forty-two years of age and had been married eight years. Menses began at twelve years, and occurred every twenty-eight days, with five days' duration. Her chief complaints were large mass in the abdomen and frequent, prolonged and profuse menstruation. She had had no children and no abortions.

Abdominal and vaginal examination revealed the presence of a mass which extended from the umbilicus to the pubis and filled the entire lower abdomen. Polypi were found attached to the cervix.

Diagnosis: Fibromyoma of uterus, polypi of cervix.

Subtotal hysterectomy was performed. The postoperative diagnosis was fibromyoma of uterus; uterus unicornis; congenital absence of right cornu, tube and ovary. (Figs. 7 and 8.)

CASE IV. M. C. was twenty-eight years of age and married four years. Menses began at fifteen years, and occurred every twenty-eight days, with two to three days' duration; the flow was moderate and painful. Her complaint was sterility.

Roentgen examination following peruterine injection of iodized oil showed the presence of uterus unicornis. (Fig. 9.)

CASE V. J. F., age thirty-one was married at thirteen years of age. Menses began at sixteen years, and occurred every twenty-five days, with four to five days' duration. Her last menses began on July 11, 1940, i.e., forty days before admission to the hospital. She was gravida 3, para 2. She delivered living children thirteen years ago and nine years ago. Both of these pregnancies were complicated by toxemia, hypertension and edema; there were no convulsions. A third pregnancy occurred three years ago and terminated in a stillbirth at six months. The patient had gonorrhea ten years ago. Contraceptives had been used for the past three years.

She complained of right-sided abdominal pain which lasted for one month. Vaginal bleeding occurred for forty days. One month before admission the patient began to have pain in the right lower abdominal quadrant with radiation to the

right flank and loin. The pain was intermittent and moderately severe. On July 11, 1940, menstruation commenced. It continued for fourteen days, ceased for two days, then resumed and continued for twenty-four days longer. Bleeding was moderate in amount. There were no fever, chills or vomiting.

Physical examination revealed no masses palpable in the abdomen. Pelvic examination revealed a small cystorectocele. There was slight descent of the cervix which was drawn to the right and obliterated the right fornix. The cervix was also drawn forward by adhesions and lay close to the pubis. The uterus lay to the right. Extending from its left border and reaching almost to fundal level was a cystic mass which on vaginal examination could not be clearly mapped out, but which on rectovaginal examination appeared to extend posterolaterally and had the consistency and contour of cystic adnexal tumor.

Cystoscopic examination showed that the bladder mucosa was normal throughout. The left ureteral orifice was seen in the usual situation, but after a search of twenty minutes following the injection of indigo carmine which appeared on the left side in four minutes, no orifice or excretion of indigo carmine could be seen on the right side. A left pyelo-ureterogram was done with 12 cc. of 30 per cent hippuran solution. In view of the fact that no right kidney shadow appeared on the *x*-ray, and that there was no right renal shadow in the intravenous pyelogram, and that no orifice was seen in the bladder, it was inferred that the right kidney and ureter were congenitally absent.

Supravaginal hysterectomy and bilateral salpingo-oophorectomy were carried out.

Diagnosis: Double uterus; uterus bicornis, unicollis, vagina simplex; bilateral pyosalpinx, and absence of right kidney.

The pathologist's report indicated that there were bilateral pus tubes, two uteri and one cervix. (The illustration was prepared after the uterus had been split open. It shows that the two components of the uterus were connected only by the supravaginal portion of the cervix.) (Figs. 13 and 14.)

Case VI. S. C., age twenty-eight, had been married five years. Menses began at twelve years, and occurred every twenty-eight days, with seven days' duration; there was no pain.

Four abortions occurred, the last one December 11, 1937. Peruterine injection of iodized oil was performed five months after the fourth abortion. The patient had her last menses on February 10, 1939, and started to bleed on April 19, 1939. She expelled a uterine cast which on microscopic examination proved to be decidual tissue. This came from the non-pregnant right uterus. (Fig. 15.) Five days later the patient started to bleed profusely from the pregnant left uterus. Some products of conception were expelled but bleeding continued and the left uterus was curetted. The curettements showed chorionic villi. (Fig. 16.)

Diagnosis: Uterus duplex, bicornis, bicollis; vagina septa. (Figs. 17 and 18.)

Case VII. M. G., age twenty-four, had been married two years. Menses began at twelve and one-half years, and occurred every twenty-eight to thirty-four days, with seven to eight days' duration, and was very painful. Her complaint was sterility.

On vaginal examination the vagina was found to be traversed by a septum, which divided it into a comparatively spacious channel on the left side and a

narrower one on the right. There were two cervices and two uteri. By the introduction of sounds it was ascertained that the right cervix and uterus were larger than those on the left. The patient refused roentgenologic study.

The patient had been having intercourse in the wider left vagina, which led to the smaller left-sided uterus. She was instructed to retract the septum and have coitus in the right-sided vagina. This was done and conception followed immediately. She was delivered by cesarean section.

Two years later the patient again complained of sterility and again was instructed to retract the septum and have intercourse in the narrower vagina. Conception occurred again. She was again delivered by cesarean section.

Diagnosis: Uterus duplex, bicornis, bicollis; vagina septa. (Fig. 19.)

CASE VIII. E. B., age twenty-one, was married one year. Menses began at twelve years, and occurred every twenty-eight days, with five days' duration. Dysmenorrhea was present the first two days of period. She had had no children. The last menses occurred October 21, 1940, and was normal. She was admitted to the hospital November 22, 1940. Her complaint was severe lower abdominal pain and vaginal bleeding of two days' duration.

Vaginal examination revealed that the uterus was retroflexed and sinistroverted. In the upper part of the vagina there was a septum directed obliquely toward the left lateral wall, forming a pocket on the right side of the septum. Urologic study showed normal kidneys and bladder. Uterosalpingography after injection of iodized oil showed absence of the right cornu and tube. The left tube was filled with the opaque medium and the opaque medium was disseminated in the peritoneal cavity. Vaginogram showed a filling defect caused by a septum in the middle of the vagina.

On January 10, 1941, the vaginal septum was excised and a septum in the cervical canal was revealed. The patient was discharged on January 25, 1941. On November 8, 1941, she was readmitted to the hospital in active labor after thirty-four weeks of gestation. A premature living female infant was delivered spontaneously. The baby died thirty hours after delivery. The third stage of labor was prolonged for thirty-five minutes because the placenta was caught in the cervical canal; it was removed manually. The patient was discharged on the tenth postpartum day in good condition.

Diagnosis: Uterus unicornis, uterus biforis; vagina septa. (Figs. 20 to 24.)

CASE IX. A. S., age thirty, had been married eight years. Menses began at ten years, and occurred every thirty days, with five days' duration, and was occasionally painful. Her complaint was sterility.

Examination revealed septate vagina, two cervices and bicornate uterus. Uterosalpingogram revealed not only the bicornate uterus, but showed a defect in the septum between the two uteri. A sound put into the right cervix went into the left uterus and vice versa. The patient conceived shortly thereafter and was delivered by cesarean section. At the operation the septum between the uteri was found to be incomplete. The baby's body was in the larger right uterus and the feet were thrust through the defect in the septum into the smaller uterus. A living female baby was delivered with a mild degree of club-foot (metatarsus varus), which was treated successfully. Three years later another living baby was delivered by cesarean section.

Diagnosis: Uterus duplex, bicornis, bicollis; vagina septa. (Figs. 25 to 30.)

CASE X. E. J., age twenty-three was unmarried, para 0, gravida 1. Menses began at thirteen years, and occurred every twenty-eight days. The last menstruation began September 15, 1936. She was admitted to the hospital October 25, 1936. Her chief complaints were lower abdominal pain for three months and bleeding for forty days.

An elastic mass was palpable on the right side of the abdomen. This mass apparently extended upward from the pelvis to within 6 cm. of the umbilicus. The vagina was divided in two by a septum. The cervix in the right vagina was effaced and small, the os admitting a fingertip. The cervix was thinned out with the result that the os occupied almost the entire cervix. This cervix was continuous upward with the elastic mass palpable through the abdomen. Evidently the elastic mass was a uterus three months pregnant. The cervix in the left vagina was conical and smaller in diameter than the examiner's fifth finger, the os being as big as a pinhole. This cervix continued upward into a mass about 4 cm. long which was apparently a non-gravid uterus.

On November 3, 1936, the patient expelled a fetus. On the next day, under general anesthesia, the placenta was removed from the right uterus and the right uterine cavity was swept over with a dull curette. At a later date roentgen studies showed the presence of uterus didelphys with one fallopian tube in each uterus. There was a sinus connecting the supravaginal portion of both cervices. (Fig. 32.) An attempted Strassmann plastic operation proved unsuccessful and hysterectomy was necessary. (Figs. 31 and 33.)

CASE XI. S. L., age thirty-one, had been married two years. Menses began at thirteen years, and occurred every three weeks, with four days' duration; it was profuse and painful. Her complaints were primary sterility, frequent, prolonged, and profuse menstruation.

On bimanual examination, the uterus was found to be slightly enlarged, anteflexed and irregular. There were two uterine fibromas, one about 5 cm. in diameter at the fundus, its major portion apparently forming part of the uterine wall, the other about 3 cm. in diameter located at the right cornu. Peruterine insufflation with oxygen and injection of iodized oil was done. Uterosalpingogram outlined the indentation produced by the fibroma at the fundus and also showed that the right oviduct was occluded at the proximal end of its isthmic portion. The filling defect produced by the fibroid in this uterosalpingogram simulated bicornate uterus. This illustrates the importance of uterosalpingography. Myomectomy was performed. The patient subsequently conceived and was delivered of a healthy female baby by cesarean section at term. (Fig. 35.)

CASE XII. R. C., age twenty-six had been married one year. Her complaint was sterility.

Examination revealed elongation of the right cornu. In such cases one can expect malpresentation of the fetus as in Figure 6. The head of the baby is in the smaller cornu and the extremities are caught in the elongated cornu. (Fig. 36.)

CASE XIII. S. D., age thirty-eight, had been married five years. Menses began at fourteen years, and occurred every six to eight weeks, with three days' duration; it was moderately painful. Her complaint was sterility.

Bimanual examination disclosed a small uterus with a depression at the summit of the fundus, a conical cervix, pinhole os and single vagina.

After injection of iodized oil, the roentgenogram showed rudimentary bicornate uterus. The tubes were not visualized but free oil in the peritoneum indicated that they had filled and then emptied themselves into the abdominal cavity.

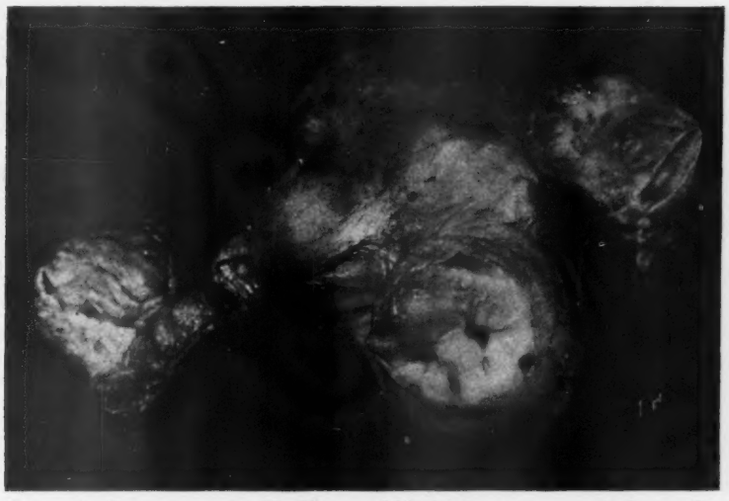

FIG. 38. CASE XIV, A. H. Uterus biforis (septate cervical canal); multiple adenomyomas; bilateral tubo-ovarian abscess. (Courtesy of Dr. Peter M. Murray.)

Diagnosis: Uterus bicornis, unicollis; vagina simplex. (Fig. 37.)

CASE XIV. A. H. (Courtesy of Dr. Peter M. Murray). Operation was performed March 10, 1941.

Diagnosis: Adenomyoma uteri, bilateral tubo-ovarian abscess, uterus biforis (septum of cervix). (Fig. 38.)

CASE XV. M. A. was married three and one-half years. She had no children and no abortions. Menses began at thirteen years, and occurred every thirty days, with six days' duration. The amount was normal and not painful. The last menses occurred July 20, 1944.

The patient had a marked indentation at the fundus. It was a typical uterus arcuatus. Roentgen pelvimetry at term showed that she had a justomajor pelvis (gynecoid-dolicopellic or anthropoid.) The true conjugate was 13.5 cm. The transverse diameter at the inlet was 12.5 cm. The volume of the true conjugate was 1,225 cc. The volume of the transverse diameter was 1,000 cc. The volume of the bi-ischial diameter was 600 cc. A brow presentation later became a left occipito-posterior position.

Onset of labor occurred at forty-one weeks. Labor was short, lasting only four hours, but the fetal heart sounds became slow and irregular. Low forceps were applied. A living baby was obtained. The third stage was normal.

CASE XVI. J. C., age twenty-five, had been married two years. There had

been no children. Menses began at thirteen years, and occurred every twenty-eight days, with three to four days' duration.

Examination revealed a double uterus, two cervices, and double vagina. The patient did not submit to roentgenographic study, and therefore the exact type of malformation cannot be stated.

Probable Diagnosis: Uterus didelphys.

CASE XVII. R. Z., age twenty, unmarried, had never menstruated. Her complaint was amenorrhea.

Examination revealed a vagina 1 cm. deep. The left ovary was present but the right ovary and uterus were not felt. The patient did not submit to urologic study and therefore it could not be stated whether she had any congenital abnormalities of the urinary tract.

CASE XVIII. S. J., age thirty-two, unmarried, had never menstruated.

Examination showed slight indentation where the introitus of vagina should be. Rectal examination revealed the presence of a small left ovary and the absence of a uterus. The patient had normal secondary sexual characteristics. Since no operation was performed it is impossible to state whether the uterus and right ovary were rudimentary or absent. The patient did not submit to urologic study; hence it could not be stated whether congenital abnormalities of the urinary tract were present.

CASE XIX. C. B., age twenty-eight, married three months, had never menstruated. The patient had normal secondary sexual characteristics.

Rectal examination revealed the presence of two small ovaries but the uterus could not be palpated. There was no vagina, but only a depression about 1 cm. deep.

The vaginal depression was dilated with graduated metal dilators to permit sexual relations. The patient did not submit to urologic study.

SUMMARY

1. A review of malformation of the uterus, with special emphasis on the more recent American literature, has been presented.

2. The embryology of these malformations has been reviewed briefly. A simplified system of classification has been proposed and a description of the basic types of uterine anomalies has been given. The parallel has been drawn between these malformations in the human female and the existence of similar forms in lower animals.

3. The relative frequency of these malformations, particularly as found in hospital statistics, has been indicated.

4. The physiological effect of such malformations has been considered. The danger of anomaly when complicated by pregnancy and labor is emphasized.

5. Methods of diagnosing these malformations have been considered and the advantages of uterosalpingography emphasized.

6. Surgical correction has been discussed briefly and the importance of conservative measures stressed.

7. A series of case histories is presented.

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ETHICALLY PROMOTED—
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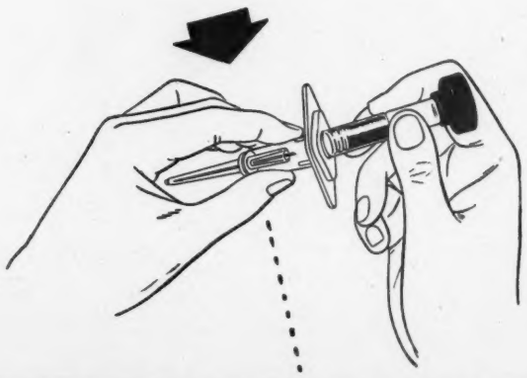
WHITE LABORATORIES, INC.
Pharmaceutical Manufacturers,
Newark 7, N. J.



Easier than loading an automatic pencil

A new and simple method for administering penicillin by the Romansky oil and wax formula is now available with the *disposable* plastic syringe set offered by Abbott Laboratories. The set, ready for immediate use, consists of a "one-shot" cartridge containing a 1-cc. dose of 300,000 units of Penicillin Calcium, Abbott, in oil and wax, and a plastic syringe with a fixed sterile needle. Recent reports have pointed out the clinical effectiveness of a *single* daily intramuscular injection of the calcium salt of penicillin suspended in a mixture of peanut oil and beeswax. With this formula there were, however, certain troublesome features to contend with in its administration, one of which was the difficulty of withdrawing the viscous penicillin suspension from a bulk container. The new *Abbott* technique completely eliminates all such drawbacks. Furthermore, since no sterilization or drying of needle or syringe is necessary, complications caused by traces of water remaining in needle or syringe cannot occur. This new syringe and cartridge is especially convenient for use in those cases of gonorrhea and staphylococcic, pneumococcic and other infections for which the Romansky formula of Penicillin may be indicated.

ABBOTT LABORATORIES, NORTH CHICAGO, ILLINOIS.

ABBOTT
PENICILLIN CALCIUM
In Oil and Wax
(ROMANSKY FORMULA)
IN CARTRIDGES WITH SYRINGES

Other New Abbott Penicillin Specialties

PENICILLIN OINTMENT
1000 units Penicillin Calcium per Gram (*in 1-ounce tubes*)

PENICILLIN OPHTHALMIC OINTMENT
1000 units Penicillin Calcium per Gram (*in ⅛-ounce tubes*)

PENICILLIN TROCHES
Each Troche contains 1000 units (*in bottles of 24*)

PENICILLIN BUFFERED TABLETS
Each tablet contains 25,000 units (*in bottles of 12 and 25*)

Wider range

topical sulfonamide therapy

An important contribution to the therapy of pyogenic infections and burns, wounds and other lesions where infection threatens . . .

SULFA-CEEPRYN CREAM

Sulfathiazole, Sulfanilamide and Cetylpyridinium Chloride

ONE-OUNCE TUBES AND ONE-POUND JARS

COMBINATION OF SULFONAMIDES — Sulfathiazole 10% and sulfanilamide 10% provide *rapid* and *prolonged* bacteriostatic action of wider scope than that of either sulfonamide alone.

REINFORCED WITH CEEPRYN—Cetylpyridinium chloride 1:500 reinforces the sulfonamides with its powerful germicidal action, and its marked detergency aids penetration.

WATER-SOLUBLE BASE — A special vanishing cream base spreads evenly and releases medication readily.

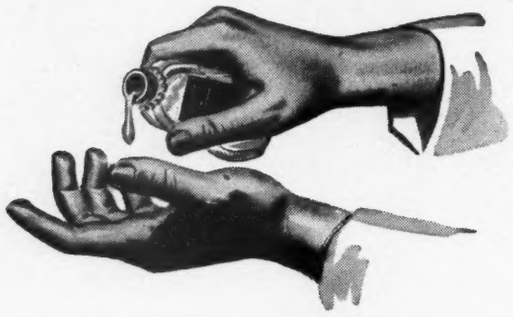
Trademarks "Ceepryn" and "Sulfa-Ceepryn" Reg. U. S. Pat. Off.

MERRELL
Since 1828

THE WM. S. MERRELL COMPANY · CINCINNATI, U. S. A.

HOW MANY TIMES DID YOU WASH YOUR HANDS TODAY?

To help *prevent* rough hands caused by frequent washing

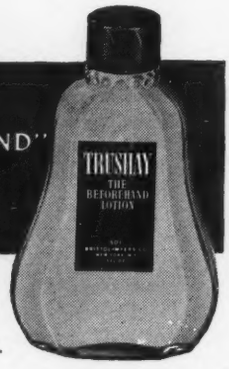


...a few drops of TRUSHAY, applied *before* washing, gives two-fold protection:

1. TRUSHAY forms a film over the skin surface to help guard against the harsh effects of cleansing and antiseptic agents... helps keep hands smooth and soft.

2. TRUSHAY protects hands by helping to keep skin normal and unbroken!

Trushay THE "BEFOREHAND" LOTION



A Product of BRISTOL-MYERS COMPANY, 19 NF W. 50th St., New York 20, N. Y.

INJECTABLE WHOLE OPIUM

In all cases requiring opiates, Pantopon 'Roche' is preferred by thousands of physicians, for Pantopon contains all the alkaloids of opium in water-soluble form suitable for injection. It is a highly purified preparation freed from the gums, resins and waxes occurring in the crude drug. Pantopon 'Roche' is available in ampuls, in hypodermic and oral tablets, and in powder form.

HOFFMANN-LA ROCHE, INC., ROCHE PARK, NUTLEY 10, N. J.

PANTOPON 'ROCHE'

COOK COUNTY
GRADUATE SCHOOL OF MEDICINE

(In affiliation with COOK COUNTY HOSPITAL) Incorporated not for profit

Announces continuous courses

SURGERY—Two Weeks Intensive Course in Surgical Technique starting January 14, January 28, and every two weeks thereafter. Four Weeks Course in General Surgery starting January 28.

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GENERAL, INTENSIVE AND SPECIAL COURSES IN ALL BRANCHES OF MEDICINE, SURGERY AND THE SPECIALTIES

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COOK COUNTY HOSPITAL

Address: Registrar, **427 South Honore Street, Chicago 12, Illinois**

THE NEW YORK POLYCLINIC
MEDICAL SCHOOL AND HOSPITAL

(ORGANIZED 1881)

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OBSTETRICS AND GYNECOLOGY

A full time course. In Obstetrics: lectures; prenatal clinics; witnessing normal and operative deliveries; operative obstetrics (manikin). In Gynecology: lectures; touch clinics; witnessing operations; examination of patients pre-operatively; follow-up in wards post-operatively. Obstetrical and Gynecological pathology. Regional anesthesia (cadaver). Attendance at conferences in Obstetrics and Gynecology. Operative Gynecology (cadaver).

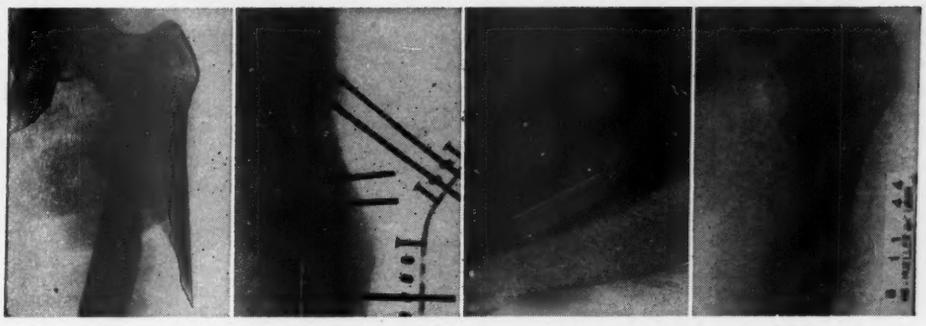
PHYSICAL THERAPY

Didactic lectures and active clinical application of all present-day methods of physical therapy in internal medicine, general and traumatic surgery, gynecology, urology, dermatology, neurology and pediatrics. Special demonstrations in minor electrosurgery, electrodiagnosis, fever therapy, hydrotherapy including colonic therapy, light therapy.

FOR INFORMATION ADDRESS

MEDICAL EXECUTIVE OFFICER, 345 West 50th Street, NEW YORK 19

The New CLAYTON TRANSFIXION SPLINT *by Siebrandt*



Write for full information about CLAYTON SPLINTS; GOODWIN BONE CLAMP; and FINGER TRAP ATTACHMENT

ANNOUNCEMENT

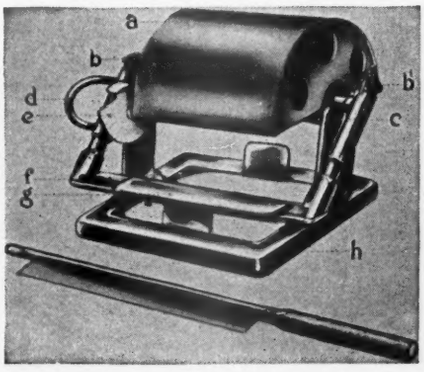
A NEW PORTABLE FRACTURE TABLE

by Siebrandt

Will be exhibited in Booth 39 at the Orthopaedic Convention, Chicago, Jan. 19, 1946

SIEBRANDT MFG. CO., INC. 3239 Troost Ave., Kansas City 3, Mo.

PADGETT-HOOD DERMATOME



By means of this unique instrument a sheet of skin of uniform thickness may be cut at any predetermined level the size of the drum (4 x 8 inches) from any area of the body. Those who have used the dermatome state that it simplifies the technique and enlarges considerably the whole field of skin grafting. Same blade used for drum may be placed in handle and used to cut razor grafts or for honing blade. Rubber cement for the drum and donor area also is available, as well as a knife sharpening service.

Manufactured and sold by

The Kansas City Assemblage Company

609 EAST 17th ST., KANSAS CITY 8, MO.

For T. & A. *and/or* E. N. & T. Treatment

The model illustrated—408W—is the choice of many specialists—for private or institutional service. Among its outstanding features are the distinctive positive-acting rotary pump, overflow trap, explosion-proof motor, non-arcing switch, sound-proof cabinet equipped with vacuum gauge and regulator, snap-fit suction and ether bottles, sinus cleanser and sprays.

Write for descriptive folder.

C. M. SORENSEN CO., Inc.
Factory, General Office and Showroom
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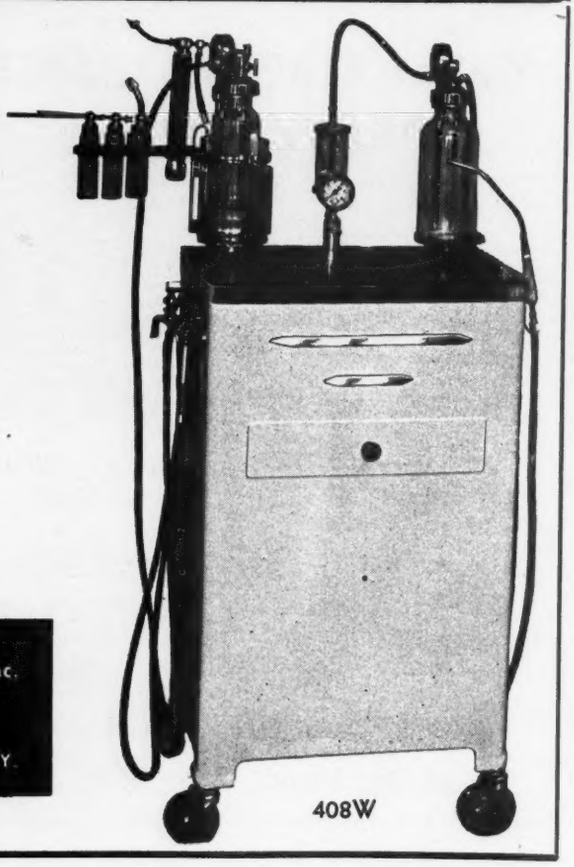


408W

Deknatel

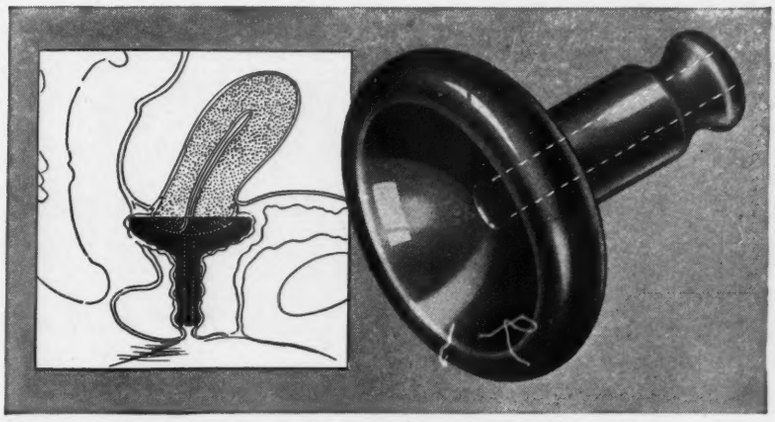
SURGICAL NYLON

Deknatel has developed this suture by *braiding* duPont nylon yarn into a strand, and then giving it a *special treatment*. It is moisture and serum resistant, has ample working tensile strength; precise diameter, unusual smoothness, pliability and other attributes . . . *plus* it is wholly synthetic and thus chemically inert. *Test it yourself.*

DEKNATEL

QUEENS VILLAGE 8, (L. I.) NEW YORK

An Improved Device for Treatment of Inoperable Uterine Prolapse



The Emmert-Gellhorn Pessary with new drainage features

In this modification by Dr. Frederick V. Emmert, the original Gellhorn pessary for relief of inoperable prolapse has been improved with great success. The new pessary is made of one piece of Neicomold, a boilable synthetic material, unbreakable, smooth and unaffected by the genital secretions. Neither does it irritate or affect the vaginal mucosa. Instead of a solid stem, the Emmert-Gellhorn pessary employs a stem drilled throughout its length. This offers the advantage of drainage, preventing accumulation of secretions. Fewer removals of the pessary for cleaning are thus needed; a great benefit to aged patients. For greater comfort, the stem is ¼ inch shorter than that of the former pattern, and has no knob. The stem, however, is hollowed to permit easy grasp for removal.

8E5162A—Emmert-Gellhorn Pessary, diameter 2 or 2½ inches, state size, each.....**$2.25**

8E5162B—Special Sizes—2¼, 2¾ or 3 in., each.**$2.75**

A. S. ALOE COMPANY

1831 Olive St. — St. Louis 3, Mo.

Vanco Sanitary Sheet Apparatus

A Clean Sheet for Every Patient

A NEW CLEAN, WHITE PAPER SHEET IS PULLED DOWN ON THE EXAMINING TABLE.

BY SIMPLE TEAR, THE SHEET IS REMOVED FROM THE TABLE.

COVERED AGAIN WITH A NEW SHEET, THE TABLE IS READY FOR THE NEXT PATIENT.

Adujstible and easily attached to either wood or metal table, this *Vanco* fixture holds approximately 300 sheets of soft, snow-white paper of special pliable texture.

Fastidious patients will welcome this innovation. Neat. Sanitary. Comfortable. An ingenious device prevents slipping of sheet, and affords complete protection for your patients.

No more laundry bills. No more expense for new linen. Vanco complete $10.50 each. Extra rolls (approximately 300 applications) $3.00 each.

Patented

Write for literature.

Order through your dealer.

FRED HASLAM & CO., INC.

83 Pulaski St. Brooklyn, N. Y.

IODINE . . . A PREFERRED ANTISEPTIC

Quick and Lasting . . .

Reliance which the Profession has placed on Iodine for so many years is a tribute to its efficiency.
In preoperative skin disinfection, as an antiseptic for use in the office and on calls, Iodine provides quick bactericidal efficiency and lasting effectiveness.

★ **IODINE** *Foe of Infection* ★

Iodine Educational Bureau, Inc. 120 Broadway, New York 5, N. Y.

USE

LAVORIS

When Epidemics Threaten

Use the Best Mouthwash

Give the mouth and throat extra care

Routinely...

IN POST-SURGICAL MANAGEMENT

Modern postoperative management calls for "full diet as soon as tolerated." This order recognizes the intimate relationship between rapid recovery and well maintained nutritional state. The more rapidly the increased metabolic demands imposed by surgery are satisfied, the more quickly will strength and stamina be restored.

Many surgeons have found that the nutritional advantages offered by Ovaltine go far in providing the nutriments so urgently required. This delicious food drink, made with milk, supplies adequate proteins, rapidly assimilated carbohydrate, highly emulsified fat, and essential vitamins and minerals. Three glassfuls daily early in the postsurgical period appreciably augment the intake of these nutritional elements and contribute significantly in satisfying the daily needs. The delightful taste of Ovaltine assures its being taken with relish, both as a mealtime beverage and between meals. "Ovaltine t.i.d." is sound nutritional therapy.

THE WANDER COMPANY, 360 N. MICHIGAN AVE., CHICAGO 1, ILL.

Ovaltine

Three daily servings of Ovaltine, each made of ½ oz. Ovaltine and 8 oz. of whole milk,* provide:

PROTEIN	31.2 Gm.	VITAMIN A	2953 I.U.
CARBOHYDRATE	62.43 Gm.	VITAMIN D	480 I.U.
FAT	29.34 Gm.	THIAMINE	1.296 mg.
CALCIUM	1.104 Gm.	RIBOFLAVIN	1.278 mg.
PHOSPHORUS	.903 Gm.	NIACIN	7.0 mg.
IRON	11.94 mg.	COPPER	.5 mg.

***Based on average reported values for milk.**

REG. U. S. Wyeth PAT. OFF.

A RATIONAL ATTACK on *peptic* ulcer is to inactivate *pepsin* without upsetting the acid-base balance of the body.

Unlike compounds of magnesium, calcium or sodium, which neutralize pepsin only because they produce an alkaline reaction, AMPHOJEL *precipitates* pepsin in a highly acid medium (pH 2 or less); it buffers gastric acid without danger of alkalosis; and it forms a protective coating over the mucosal surface.

AMPHOJEL

REG. U. S. PAT. OFF.

IN PEPTIC ULCER

Prompt relief of pain • Rapid healing

Wyeth

WYETH INCORPORATED • PHILADELPHIA 3 • PA.

ACCELERATING RESPONSE IN RESISTANT BURNS • WOUNDS • ULCERS

Topical application of vitamins A and D in slow-healing burns, wounds, ulcers, is a clinically accepted procedure of proved therapeutic value.

White's VITAMIN A AND D OINTMENT

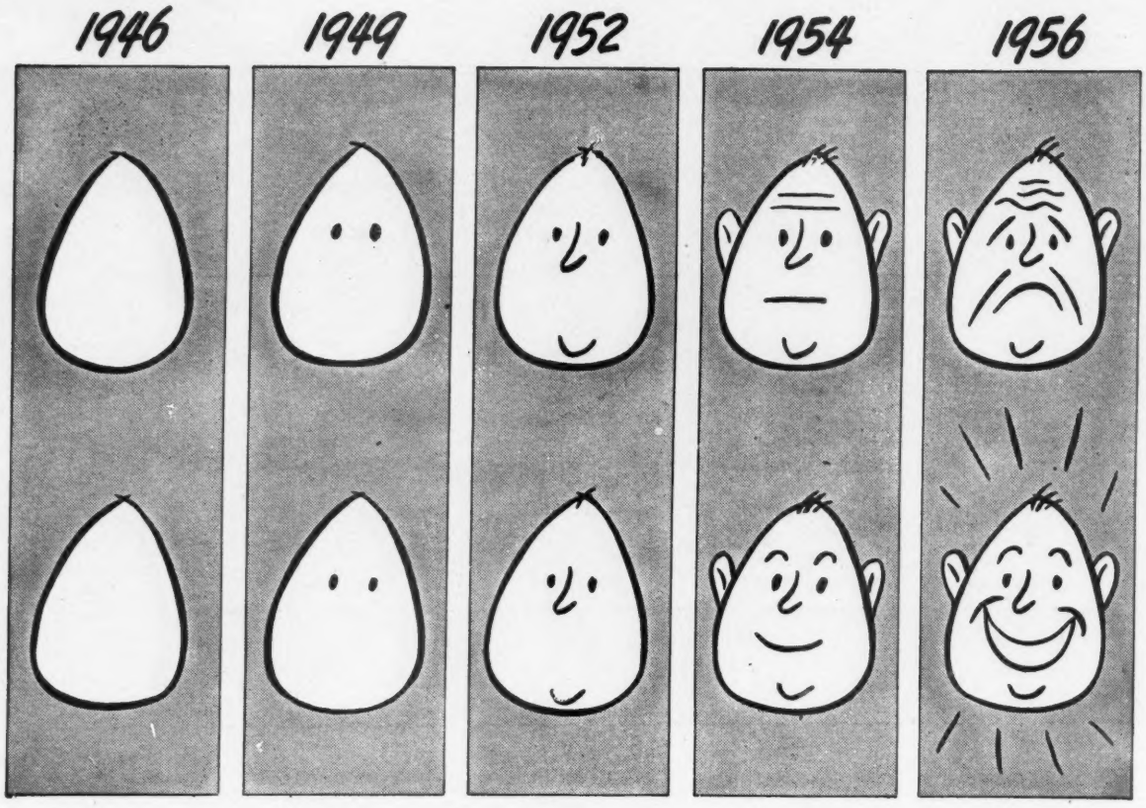
provides these vitamins, derived from fish liver oils, present in ratio as found in cod liver oil, in an appropriate lanolin-petrolatum base. Particularly efficacious in chronic wounds which have not responded favorably to previous treatment.

Promotes healthy granulation and rapid epithelization without destruction of epithelial elements. Inhibits infection. Lessens need for skin grafting. Forms no tenacious coagulum. No unpleasant odor or excessive oiliness; keeps indefinitely at ordinary temperature.

Supplied in 1.5 oz. tubes; 8 oz. and 16 oz. jars; 5 lb. containers.

Ethically promoted—not advertised to the laity.

White
LABORATORIES, INC.
NEWARK 7, N. J.



Two ways your face can grow in the next few years

USUALLY, our faces show what's happening to us.

For instance, suppose financial matters are constantly on your mind.

Suppose you know that there's practically no cash reserve between you and trouble.

It would be surprising if your face didn't show it.

But suppose that, on the contrary, you've managed to get yourself on a pretty sound financial basis.

Suppose that you're putting aside part of everything you earn . . . that those dollars you save are busy earning *extra* dollars for you . . . that you have a nest egg and an emergency fund.

Naturally, your face will show *that*, too.

There's a simple and pretty accurate way to tell which way your face is going to go in the next few years:

If you are buying, regularly, and holding as many U. S. Savings Bonds as you can, you needn't worry.

Your face will be among the ones that wear a smile.

Buy all the Bonds you can... keep all the Bonds you buy!

THE AMERICAN JOURNAL OF SURGERY

This is an official U. S. Treasury advertisement—prepared under auspices of Treasury Department and War Advertising Council

A Valuable Routine Measure

Prescribed routinely before elective surgery, LIVITAMIN reduces operative risk by improving the ability of the patient to withstand anesthesia and surgery. Because LIVITAMIN is presented in liquid form, it may be administered early after surgery to overcome B vitamin and iron deficiencies if present, or guard against their occurrence. It aids in overcoming anorexia, speeds return to normal strength.

LIVITAMIN, notable for its palatability, and providing liver concentrate, readily utilized iron, and a rich store of B vitamins, will be found a valuable aid in hastening postsurgical recovery.

LIVITAMIN

Each fluidounce of Livitamin presents:

Fresh Liver (as Liver Concentrate)	2 oz.
Thiamine Hydrochloride (B_1)	3 mg.
Riboflavin (B_2, G)	1 mg.
Nicotinamide (Niacinamide)	25 mg.
Pyridoxine Hydrochloride (B_6)	1 mg.
Pantothenic Acid	5 mg.
Iron and Manganese Peptonized	30 gr.

Contains the vitamin B complex factors naturally occurring in liver and rice bran, fortified with synthetic B_1, niacinamide, B_2, B_6, pantothenic acid and with iron and manganese.

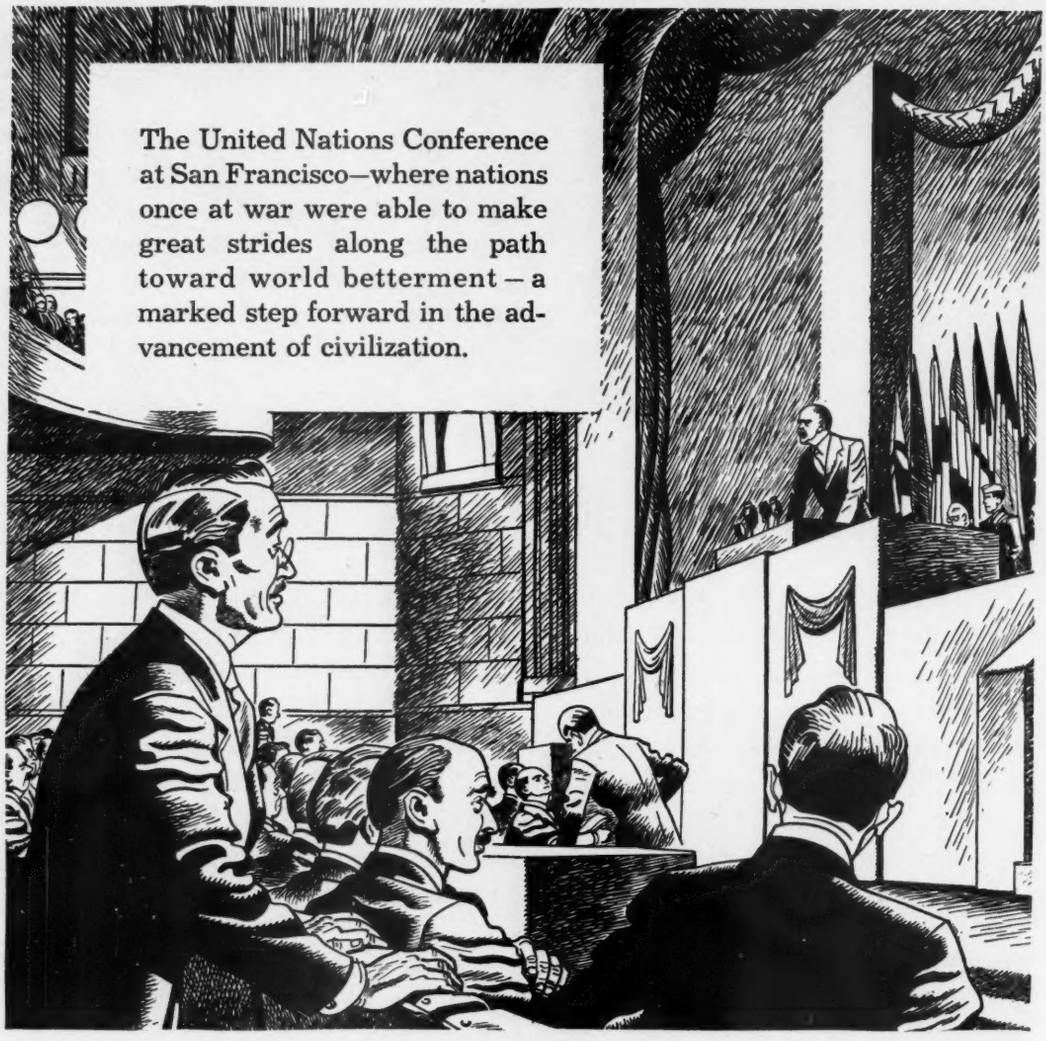
In doses of 2 to 4 teaspoonfuls t.i.d. Livitamin rapidly corrects hemoglobin deficiency. Available in 8-oz. bottles.

THE S. E. MASSENGILL COMPANY

Bristol, Tenn.-Va.

NEW YORK • SAN FRANCISCO • KANSAS CITY SEMCO

Toward a Better World


The United Nations Conference at San Francisco—where nations once at war were able to make great strides along the path toward world betterment – a marked step forward in the advancement of civilization.

Looking forward as always, Lanteen Medical Laboratories present another notable example of advanced thinking, in Lanteen Products, leaders in their field, produced under the most rigid scientific standards.

Since patients are not mechanically minded, simplicity and ease of handling are prime requisites for continued use. Lanteen Flat Spring Diaphragm is extremely simple to place—it is collapsible in one plane only. No inserter required. Distributed ethically—advertised only to the medical profession—available only upon the recommendation or prescription of a physician. Complete information upon request.

L A N T E E N

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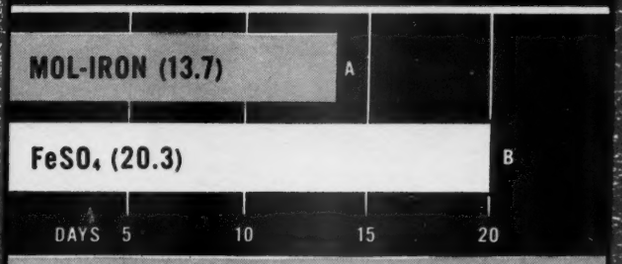
A NEW AND DEFINITE ADVANCE IN TREATING IRON-DEFICIENCY ANEMIAS

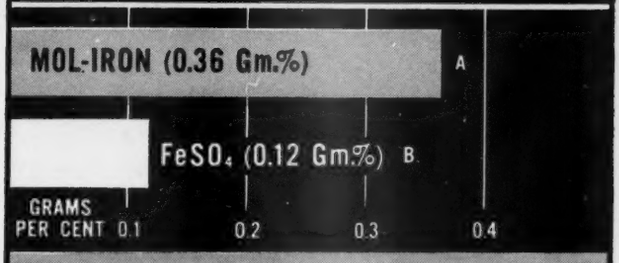
Rapidity of Clinical Response



(A) Completely effective therapeutic response (return to normal blood values) was obtained in an average of 13.7 days of Mol-Iron therapy.

(B) Ferrous sulfate therapy *failed* to produce normal hemoglobin values after an average of 20.3 days.

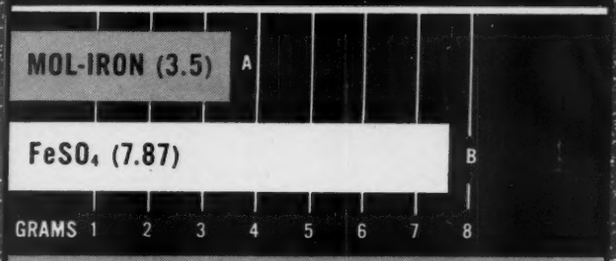
Average Daily Hemoglobin Increase



(A) The group treated with Mol-Iron averaged a daily hemoglobin increase of 2.48 per cent (0.36 Gm. per cent).

(B) The group treated with ferrous sulfate showed an average daily gain of hemoglobin of 0.83 per cent (0.12 Gm. per cent)—a response about one-third as effective.)

Therapeutic Intake of Bivalent Iron



(A) The Mol-Iron treated group received an average total of 3.528 Gms. of bivalent iron to produce the sought for result (return to normal blood values).

(B) While an average ingestion of 7.871 Gms. of bivalent iron failed to achieve an optimal response in the ferrous sulfate treated group.

The charts summarize the results of a controlled study of comparative therapeutic response in post-hemorrhagic and nutritional hypochromic anemias.

The series includes 49 cases treated with Mol-Iron and 21 with exsiccated ferrous sulfate; the results are typical of those observed in treatment of iron-deficiency anemias with White's Mol-Iron.

A specially processed, co-precipitated complex of molybdenum oxide (3 mg.) and ferrous sulfate (195 mg.).

White's MOL-IRON TABLETS

Available clinical evidence indicates that, in hypochromic anemia, the therapeutic response to this highly effective synergistic combination—as compared with equivalent dosage of ferrous sulfate alone—has unusual advantages:

1. NORMAL HEMOGLOBIN VALUES ARE RESTORED MORE RAPIDLY, INCREASES IN THE RATE OF HEMOGLOBIN FORMATION BEING AS GREAT AS 100% OR MORE IN PATIENTS STUDIED.
2. IRON UTILIZATION IS SIMILARLY MORE COMPLETE.
3. GASTRO-INTESTINAL TOLERANCE IS NOTABLY SATISFACTORY—even among patients who have previously shown marked gastro-intestinal reactions following oral administration of other iron preparations.

INDICATED IN:

Hypochromic (iron deficiency) anemias caused by inadequate dietary intake or impaired intestinal absorption of iron; excessive utilization of iron, as in pregnancy and lactation; chronic hemorrhage.

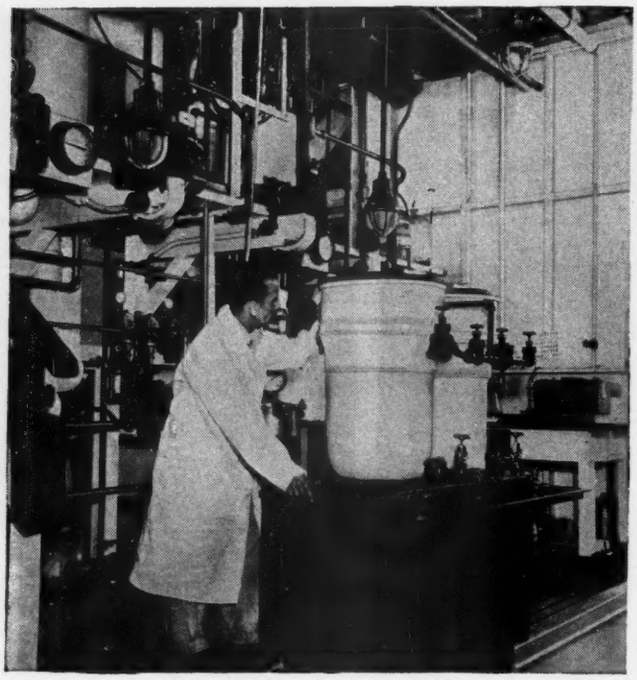
DOSAGE: One or two tablets three times daily after meals.

Available in bottles of 100 and 1000 tablets.

Ethically promoted—not advertised to the laity.

WHITE LABORATORIES, INC.

Pharmaceutical Manufacturers, Newark 7, New Jersey



Final stage in the purification of penicillin—the removal of pyrogens by filtration of the penicillin concentrate.

★ ★ ★

Penicillin Merck meets the recognized high standard of quality established for all Merck products. It is subjected to repeated tests and control procedures throughout every step of the production process, and the finished product is assayed, tested, and approved under rigid standards established by the Food and Drug Administration and by the Merck Analytical Laboratories.

★ ★ ★

A GLIMPSE AT THE RECORD

IN 1940 Merck research on antibiotics concentrated on Penicillin.

IN 1941 Merck brought about a reciprocal arrangement between British and American investigators to spur the production of Penicillin in co-operation with the United States and British governments.

IN 1942 Merck supplied Penicillin for the first case of bacteriemia successfully treated with this drug in the United States.

IN 1943 Merck sent shipments of Penicillin to England by air transport for urgent therapeutic use by the United States Army Medical Corps.

IN 1944 AND 1945 Merck produced ever-increasing supplies of Penicillin for our Armed Forces.

AND NOW, Merck production of Penicillin has reached a point where, in addition to meeting continuing military requirements, large quantities are being produced for civilian medical needs.

PENICILLIN
MERCK
ACCEPTED AMERICAN MEDICAL ASSN
Council Accepted

Literature on request

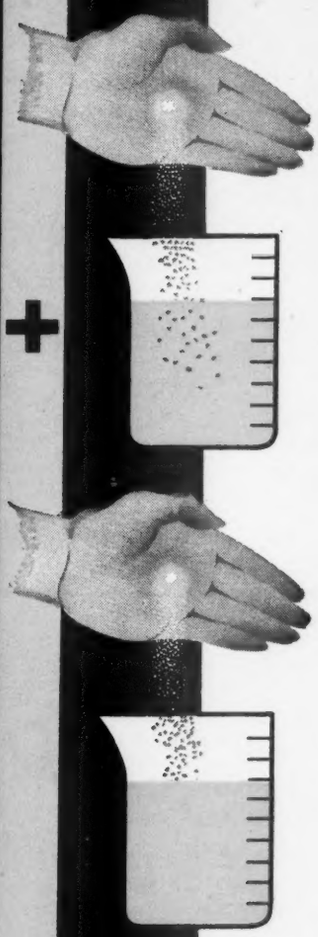
MERCK & CO., Inc. *Manufacturing Chemists* **RAHWAY, N. J.**

In Canada: MERCK & CO., Ltd., Montreal • Toronto • Valleyfield

INTRODUCING

Combisul - TD

(equal parts of sulfa*thiazole* and sulfa*diazine*) **in one tablet**



TO REDUCE RENAL TOXICITY INCIDENT TO SULFONAMIDE THERAPY

Recent experimental and clinical studies[1,2] prove that administration of sulfathiazole and sulfadiazine in combination in equal parts reduces renal complications such as crystalluria, hematuria and urinary tract blockage, and is much safer than either drug used alone in whole dosage. Simultaneously, antibacterial activity and therapeutic efficacy are maintained.

COMBISUL-TD presents 0.25 gram sulfathiazole and 0.25 gram sulfadiazine — a total of 0.5 gram per tablet. No signs of renal toxicity have been encountered by use of this mixture and even crystalluria is infrequent. The indications for, and dosage of, COMBISUL-TD are the same as for either drug administered alone. Meningitis is an exception, for which COMBISUL-DM, a combination of 0.25 gram sulfadiazine and 0.25 gram sulfamerazine is available.

COMBISUL-TD available in 0.5 gram tablets. Bottles of 100 and 1000.
COMBISUL-DM available in 0.5 gram tablets. Bottles of 100 and 1000.

1. Lehr, D.: Proc. Soc. Exper. Biol. & Med. *58*:11, 1945.
2. Lehr, D.: In press.

Trade-Marks COMBISUL-TD and COMBISUL-DM — Reg. U. S. Pat. Off.

SCHERING

Schering CORPORATION • BLOOMFIELD, N. J.
IN CANADA, SCHERING CORPORATION LIMITED, MONTREAL

THE EINHORN BILUMEN GASTRO-ENTEROSTOMY TUBE AND GASTRO-DUODENAL TUBES

as described by Dr. Moses Einhorn, New York, in Surgery, Gynecology and Obstetrics, Jan. 1941.

SPECIFICATIONS . . . D-103 GASTRO-ENTEROSTOMY TUBE. Round tube is made of special rubber, 48" long, 16 French, bisected by a center wall to give a double semi-circular lumen. Supplied with double metal outlet and rubber connectors. Each lumen can be used independently since they have separate openings at both ends.

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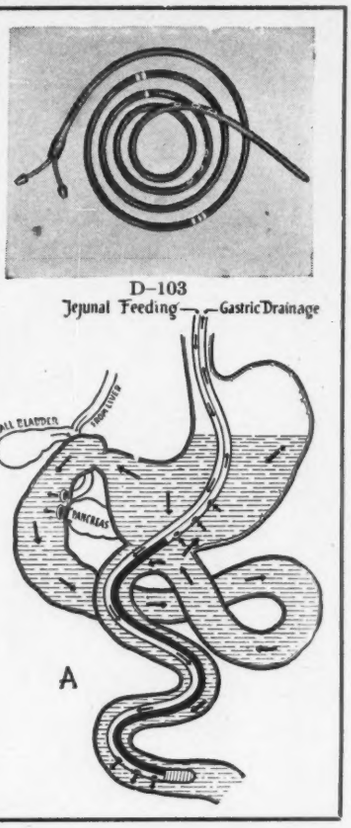

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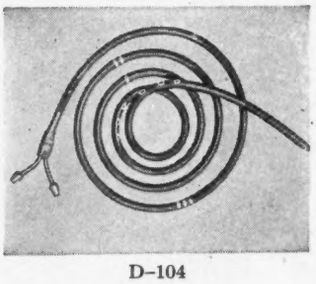

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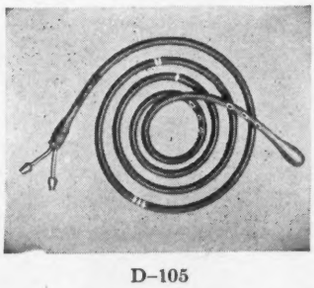

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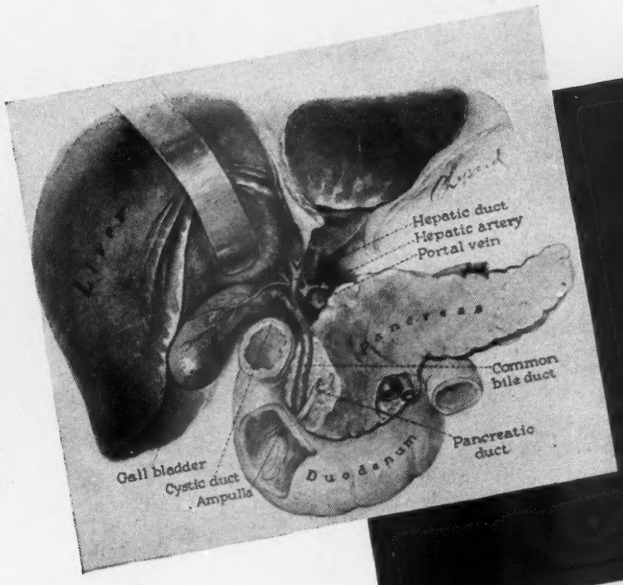

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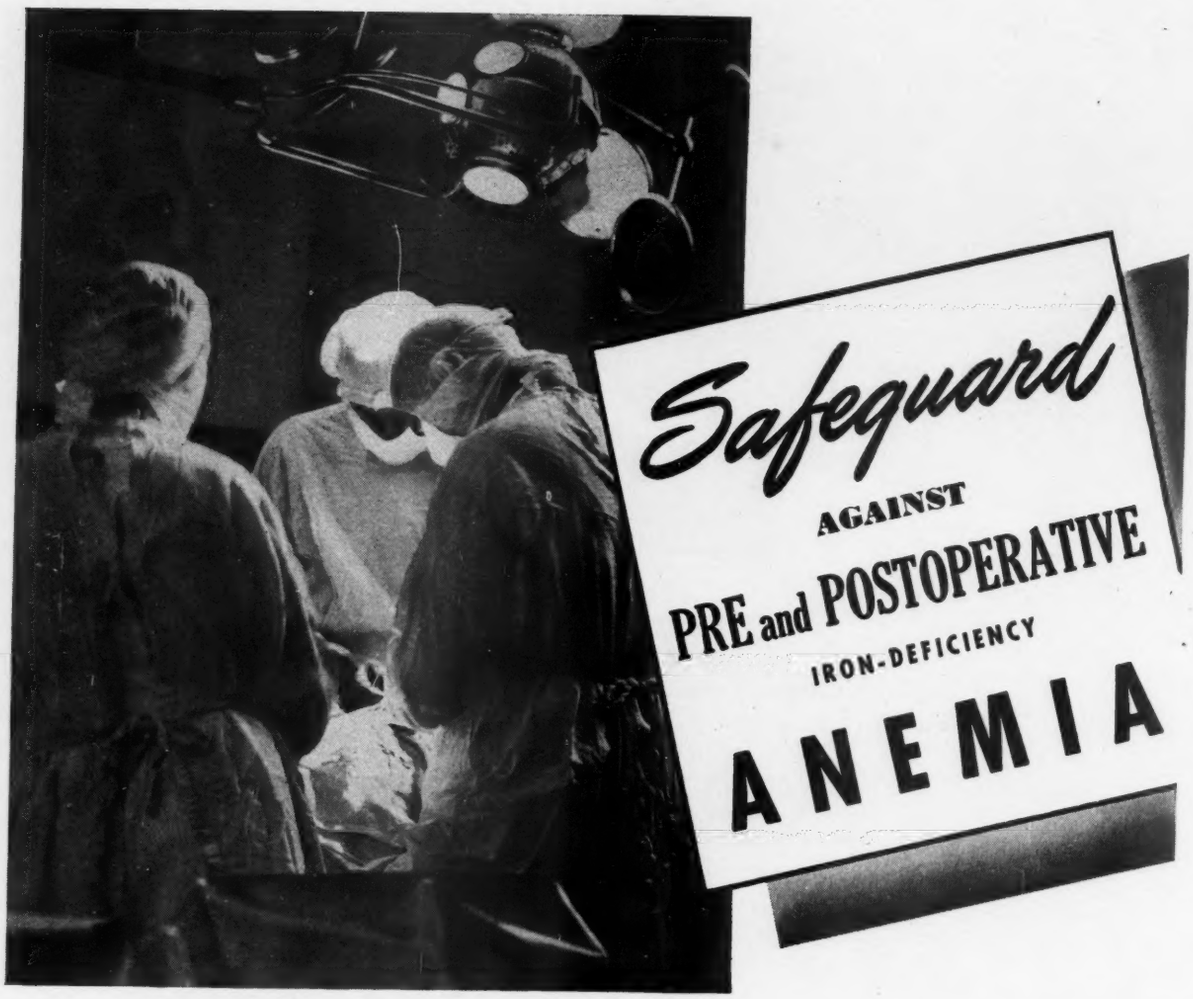

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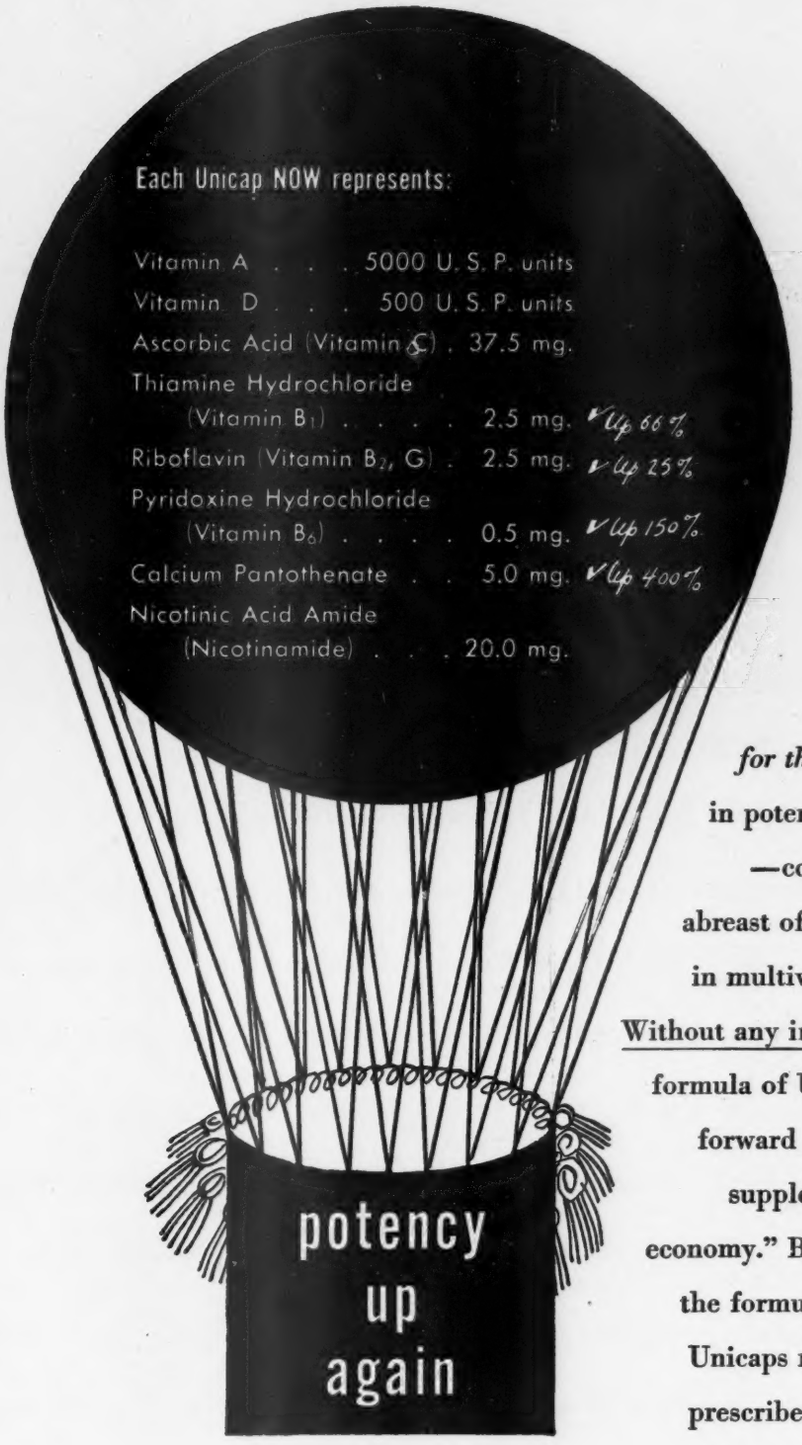
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